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A monthly publication of the Geological Survey
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The Secretary of the Interior has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Office of Management and Budget through September 1989.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

PREFACE

Selected Water Resources Abstracts, a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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THE WATER RESOURCES SCIENTIFIC INFORMATION CENTER DOES NOT PROVIDE COPIES OF DOCUMENTS ABSTRACTED IN THIS JOURNAL. Sufficient bibliographic information is given to enable readers to order the desired documents from local libraries or other sources.

Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Water Resources Scientific
Information Center
U.S. Geological Survey
MS 425 National Center
Reston, VA 22092

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01 NATURE OF WATER

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02 WATER CYCLE

Includes the following Groups: General; Precipitation; Snow, Ice, and Frost; Evaporation and Transpiration; Streamflow and Runoff; Groundwater; Water in Soils; Lakes; Water in Plants; Erosion and Sedimentation; Chemical Processes; Estuaries.

03 WATER SUPPLY AUGMENTATION AND CONSERVATION

Includes the following Groups: Saline Water Conversion; Water Yield Improvement; Use of Water of Impaired Quality; Conservation in Domestic and Municipal Use; Conservation in Industry; Conservation in Agriculture.

04 WATER QUANTITY MANAGEMENT AND CONTROL

Includes the following Groups: Control of Water on the Surface; Groundwater Management; Effects on Water of Man's Nonwater Activities; Watershed Protection.

05 WATER QUALITY MANAGEMENT AND PROTECTION

Includes the following Groups: Identification of Pollutants; Sources of Pollution; Effects of Pollution; Waste Treatment Processes; Ultimate Disposal of Wastes; Water Treatment and Quality Alteration; Water Quality Control.

06 WATER RESOURCES PLANNING

Includes the following Groups: Techniques of Planning; Evaluation Process; Cost Allocation, Cost Sharing, Pricing/Repayment; Water Demand; Water Law and Institutions; Nonstructural Alternatives; Ecologic Impact of Water Development.

07 RESOURCES DATA

Includes the following Groups: Network Design; Data Acquisition; Evaluation, Processing and Publication.

08 ENGINEERING WORKS

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SELECTED WATER RESOURCES ABSTRACTS

2. WATER CYCLE

2A. General

RUNOFF GENERATION AND HYDROLOGIC RESPONSE VIA CHANNEL NETWORK GEOMORPHOLOGY: RECENT PROGRESS AND OPEN PROBLEMS,
Mississippi Univ., University. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05841

HYDROLOGICAL PERSISTENCE CHARACTERISTICS OF FLOODS AND DROUGHTS: INTERREGIONAL COMPARISONS,
Yamanashi Univ., Kofu (Japan). Dept. of Environmental Engineering.
K. Takeuchi.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 49-67, September 30, 1988. 7 fig, 2 tab, 11 ref.

Descriptors: *Duration curves, *Geography, *Floods, *Regional analysis, *Drought, *Flood duration curves, *Drought duration curves, Water management, Japan, Graphical analysis, Management planning, Regional planning, Classification, Mapping.

Flood duration curves (FDCs) and drought duration curves (DDCs) were defined and some sample curves of precipitation and streamflow series were plotted on logarithmic paper. FDCs and DDCs represent persistence characteristics of hydrologic time series when they assume high and low values, respectively. They contain information that has direct implications on water resources management both for flood control and water use. Daily and monthly precipitation and streamflow data were collected at 6 stations in Japan and 12 stations in various parts of the world. Duration curve analyses of these data were conducted, revealing various regional differences in the persistence of variables. The duration curves make it possible to classify regions based on a purely hydrological concept, which is very different from conventional concepts developed in climatology, geography, or geology. This study represents a starting point for mapping flood and drought persistence characteristics on a worldwide basis. (Author's abstract)
W89-05843

HYDROLOGIC SAMPLING: A CHARACTERIZATION IN TERMS OF RAINFALL AND BASIN PROPERTIES,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W89-05846

HACHIOJI EXPERIMENTAL BASIN STUDY: STORM RUNOFF PROCESSES AND THE MECHANISM OF ITS GENERATION,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2E.
W89-05847

RUNOFF PROCESS ON A STEEP FORESTED SLOPE,
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Forestry.
For primary bibliographic entry see Field 2E.
W89-05848

SOME EXPERIMENTAL RESULTS CONCERNING RAPID WATER TABLE RESPONSE TO SURFACE PHENOMENA,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2F.
W89-05851

EFFECT OF INITIAL SOIL MOISTURE CONTENT ON THE VERTICAL INFILTRATION PROCESS: A GUIDE TO THE PROBLEM OF RUNOFF-RATIO AND LOSS,
Tokyo Inst. of Tech. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05854

ANALYSIS OF THREE-DIMENSIONAL GROUNDWATER FLOW IN THE NEAR-SURFACE LAYER OF A SMALL WATERSHED,
Saitama Univ., Urawa (Japan). Hydroscience and Geotechnology Lab.
For primary bibliographic entry see Field 2F.
W89-05855

EFFECT OF STORM RAINFALL INTENSITY PATTERNS ON SURFACE RUNOFF,
Agricultural Research Service, Tucson, AZ. Arid-land Watershed Management Research Unit.
D. A. Woolhiser, and D. C. Goodrich.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 335-354, September 30, 1988. 12 fig, 3 tab, 27 ref.

Descriptors: *Model studies, *Rainfall-runoff relationships, *Hydrologic models, *Infiltration, *Disaggregation methods, Spatial variation, Comparison studies, Rainfall, Catchment areas, Overland flow, Climate, Runoff.

The adoption of physically-based infiltration models as components of watershed models has been impeded because they require rainfall data with high temporal and spatial resolution, and the spatial variability of infiltration model parameters must be accounted for. Techniques have been developed to disaggregate daily rainfall into the intermittent shower process within the day, and further disaggregate significant showers into short-period rainfall hyetographs. A simple model describing infiltration and unsteady flow over a plane and a single channel was used to investigate the sensitivity of derived distributions of runoff volume and peak flow rates to input differences due to different rainfall disaggregation methods and parameters and to spatial variability of infiltration parameters. The Woolhiser and Osborn disaggregation scheme is superior to simpler forms of disaggregation for all but a highly damped system. For the elementary watershed considered, the channel has little effect on basis response compared to overland flow characteristics. A significant interaction between climate and spatially variable infiltration and its effects on response was discovered. (Author's abstract)
W89-05858

SOIL-AQUIFER-STREAM INTERACTIONS: A REDUCTIONIST ATTEMPT TOWARD PHYSICAL-STOCHASTIC INTEGRATION,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. J. Morel-Seytoux.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 355-379, September 30, 1988. 4 fig, 1 tab, 24 ref, 2 append. NSF Grant CEE-8212668.

Descriptors: *Surface-groundwater relationships, *Soil water, *Infiltration, *Hydrologic models, *Model studies, Theoretical analysis, Aquifers, Streams, Rainfall, Spatial variation, Temporal variation, Statistics, Errors, Scale factors.

An approach is suggested to describe the various interactions among soil, aquifer, and stream in a simplified but essentially physical and integrated manner. Successful passage from a smaller to a larger scale requires integration in many senses, including (1) in time, (2) in space, (3) in expectation sense, and (4) in a process sense, and an enlightened coupling. This process of multiple integration is illustrated in a simple manner for the processes of infiltration, moisture redistribution, aquifer recharge, and aquifer return flow, with emphasis on stream-aquifer interaction. It is suggested that temporal patterns of rainfall, spatial variation in soil properties, temporal fluctuations in river stage, sharp turns in flow direction (e.g., from vertical to horizontal at the interface of two soil layers) can significantly affect the response of a watershed. It is further suggested that simple techniques can be devised that account to a large extent for these influences and will provide satisfactory tools for watershed modeling. It is shown that a purely statistical ARMA approach to hydrologic modeling will lead to incorrect identification of a perfectly stationary linear system as a nonstationary one. The combined physical-stochastic approach eliminates this potential error. (Author's abstract)
W89-05859

EVALUATION OF RAINFALL-RUNOFF MODELS FROM THE STOCHASTIC VIEWPOINT,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
T. Takasao, and K. Takara.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 381-406, September 30, 1988. 12 fig, 4 tab, 34 ref, 3 append.

Descriptors: *Model studies, *Rainfall-runoff relationships, *Stochastic process, *Hydrologic models, *Model studies, Monte Carlo methods, Overland flow, Slopes, Subsurface drainage, Surface-groundwater relations, Kinematic waves, Variable source areas, Comparison studies, Mathematical models.

Hydrologic model evaluation is discussed from a stochastic viewpoint. An evaluation framework is presented which uses a Monte Carlo simulation to compare simplified models, considering whether or not they preserve the stochastic transformation properties of the runoff system represented by an ideal model. The method was applied to two types of hillslope runoff processes: (1) a simple surface runoff (overland flow) process and (2) a surface-subsurface runoff process. In the simple runoff case, the kinematic wave is regarded as an ideal one and three storage function models are compared. In the surface-subsurface runoff case, the kinematic source area variation (KSAV) model (proposed in 1962 by Ishihar and Takasao) is regarded as an ideal one, and the kinematic wave model and the lumped hillslope model are regarded as simplified. The lumped hillslope model that is derived from the KSAV model based on the kinematic wave model was found to be of great advantage for computer simulation of large river basins. The lumped hillslope model also takes much less CPU time than the KSAV model. (Rochester-PTT)
W89-05860

PARAMETERIZATION OF REGIONAL EVAPORATION: SOME DIRECTIONS AND STRATEGIES,
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2D.
W89-05861

IMPROVED GROUND HYDROLOGY CALCULATIONS FOR GLOBAL CLIMATE MODELS (GCMS): SOIL WATER MOVEMENT AND EVAPOTRANSPIRATION,
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
F. Abramopoulos, C. Rosenzweig, and B. Choudhury.
Journal of Climate JLCLEL, Vol. 1, No. 9, p 921-941, September 1988. 17 fig, 3 tab, 33 ref, append.

Descriptors: *Hydrologic models, *Global climate models, *Soil water movement, *Evapotranspiration, *Model studies, *Climatology, *Meteorology, Vegetation, Hydraulic conductivity, Hydrologic cycles, Precipitation, Dew, Brazil, Sahel, Sahara, India.

A physically based ground hydrology model is developed to improve the land-surface sensible and latent heat calculations in global climate models (GCMs). The process of transpiration, evaporation from intercepted precipitation and dew, evaporation from bare soil, infiltration, soil water flow, and runoff are explicitly included in the model. The amount of detail in the hydrologic calculations is restricted to a level appropriate for use in a GCM, but each of the above processes is modeled on the basis of the underlying physical principles. Data from the Goddard Institute for Space Studies

GCM are used as inputs for off-line tests of the ground hydrology model in four 8 degree x 10 degree regions (Brazil, Sahel, Sahara, and India). Soil and vegetation input parameters are calculated as area-weighted means over the 8 x 8 gridbox. This compositing procedure is tested by comparing resulting hydrological quantities to ground hydrology model calculations performed on the 1 x 1 cells which comprise the 8 x 10 gridbox. The compositing procedure works well except in the Sahel where lower soil water levels and a heterogeneous land surface produce more variability in hydrological quantities, indicating that a resolution better than 8 x 10 is needed for that region. Modeled annual and diurnal hydrological cycles compare well with observations for Brazil, where real world data are available. The sensitivity of the ground hydrology model to several of its input parameters was tested; it was found to be most sensitive to the fraction of land covered by vegetation and least sensitive to the soil hydraulic conductivity and matric potential. (Author's abstract)
W89-05921

CONSTANT RATE RAINFALL INFILTRATION IN A BOUNDED PROFILE: SOLUTIONS OF A NONLINEAR MODEL,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2G.
W89-06069

PRELIMINARY OBSERVATIONS OF STREAMFLOW GENERATION DURING STORMS IN A FORESTED PIEDMONT WATERSHED USING TEMPERATURE AS A TRACER,
Geological Survey, Doraville, GA.
J. B. Shanley, and N. E. Peters.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 349-365, December 1988. 9 fig, 19 ref.

Descriptors: *Surface-groundwater relations, *Rainfall-Runoff relationships, *Streamflow, *Forest watersheds, *Groundwater runoff, Water temperature, Water table fluctuation, Hydraulic gradient, Headwaters, Sulfates, Alkalinity, Georgia Piedmont, Rainstorms.

Variations in streamwater temperature at the outlet of a 41-ha forested watershed at Panola Mountain in the Georgia Piedmont indicate that the initial rapid hydrologic response is caused by a combination of groundwater discharge and channel interception of rainwater. A storm in May 1986 caused a rapid increase in discharge that was accompanied by a decrease in streamwater temperature and a rise in the water table level adjacent to the stream. The higher water table provided the hydraulic gradient necessary to increase the discharge of colder groundwater to the stream. Storms that occurred under very dry antecedent conditions in July 1986 and June 1987 caused a rapid hydrologic response but no change in water table level, indicating the response was caused by channel interception of rainwater. This conclusion was supported by increases in streamwater temperature in the June storm and by chemical changes in the July storm. When rainfall is sufficient, flow in the ephemeral part of the stream in the catchment headwaters generates a second and larger discharge peak that reflects the chemistry and temperature of runoff from a 3-ha granite outcrop in the headwaters; sulfate concentration and temperature increase and alkalinity decreases relative to prestorm conditions. The initial response, however, results from channel interception and groundwater discharge. Rapid rises in the water table level during some storms suggest that macropore flow may play a major role in the hydrologic response of the watershed to rainstorms. (Author's abstract)
W89-06434

COMPLEX MARKOV MODELS TO SIMULATE PERSISTENT STREAMFLOWS,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-06454

VALIDITY OF FIRST-ORDER PREDICTION LIMITS FOR CONCEPTUAL HYDROLOGIC MODELS,
Newcastle Univ. (Australia). Dept. of Civil Engineering.
G. Kuczera.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 229-247, November 30, 1988. 10 fig, 4 tab, 30 ref.

Descriptors: *Model studies, *Hydrologic models, *Error analysis, *Rainfall-runoff relationships, Prediction, Streamflow, Mathematical studies, Regression analysis.

First-order analysis is a powerful method for evaluating the effect of parameter uncertainty propagating through a conceptual hydrologic model. However, its validity rests on the strong assumption that a first-order approximation is valid over the region of parameter space where there is significant parameter uncertainty. It is suggested that Beale's nonlinearity measure be used to check this assumption. This measure is based on the discrepancy between actual and linearized response for parameters randomly sampled from the surface of the 90% confidence ellipsoid. Examples involving two nonlinear conceptual models demonstrate that model nonlinearity is very much application-dependent, highlighting the need to compute Beale's nonlinearity measure in all model applications. Uncertainty in hydrologic response is induced not only by parameter uncertainty propagating through the model, but also by natural uncertainty arising from model and measurement error. Approximate prediction limits based on both parameter and natural uncertainty, are developed in a regression context, which employs an error model consistent with the residual characteristics found in conceptual hydrologic model applications. An example involving an eight-parameter streamflow yield model demonstrates dominance of natural over parameter uncertainty, emphasizing the need to include both forms of uncertainty when computing prediction limits. (Author's abstract)
W89-06457

EFFECT OF BASEFLOW SEPARATION PROCEDURES ON SURFACE RUNOFF MODELS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W89-06461

HYDROLOGICAL BEHAVIOUR OF THE NILGIRI SUB-WATERSHEDS AS AFFECTED BY BLUEGUM PLANTATIONS: PART I. THE ANNUAL WATER BALANCE,
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
Samraj, V. N. Sharda, S. Chinnamani, V. Lakshmanan, and B. Haldorai.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 335-345, November 30, 1988. 9 fig, 3 tab, 6 ref.

Descriptors: *Forest management, *Watershed management, *Hydrologic budget, *Soil moisture retention, *Grasslands, *Flow rates, *Vegetation effects, Sediment yield, Sediment load, Reservoirs, Trees, Catchment areas, Water yield, Electric power production, Overland flow, Flow discharge, Runoff rates, India, Eucalyptus.

The Nilgiri Plateau in Southern India receives an average annual rainfall of 1300 mm distributed over 190 to 220 rainy days. It is estimated that the Nilgiri District alone is responsible for about 50% hydroelectric power generation in Tamil Nadu State. The effect of converting natural grasslands (grazed) in the catchments of hydel reservoirs to bluegum (Eucalyptus globulus) plantations on expected water and sediment yield has been discussed. It is estimated that bluegum, during a first rotation of ten years, brings about 16% reduction in the total expected water yield from natural grasslands. This figure is found to be significant both at 1 and 5% levels. The reduction in total flow on an average works out to be 87 mm/yr during the first rotation of ten years. During the first rotation, bluegum extracts moisture mostly from the upper soil layers and does not directly interfere with the groundwater table. The reduction in soil moisture status in the upper 50 cm soil depth is found to be significant, though at 1 m sampling depth it is significant only at 5% level. The maximum growth rate is observed from the fourth to the seventh year of plantation. Neither the natural grasslands nor the bluegum add any sediment load to the reservoirs. Caution may, however, have to be exercised while planning large-scale conversion of natural grasslands into bluegum plantations. (See also W89-06464) (Author's abstract)
W89-06463

HYDROLOGICAL BEHAVIOUR OF THE NILGIRI SUB-WATERSHEDS AS AFFECTED BY BLUEGUM PLANTATIONS: PART II. MONTHLY WATER BALANCES AT DIFFERENT RAINFALL AND RUNOFF PROBABILITIES,
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
V. N. Sharda, P. Samraj, S. Chinnamani, and V. Lakshmanan.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 347-355, November 30, 1988. 4 fig, 2 tab, 6 ref.

Descriptors: *Forest management, *Hydrologic budget, *Rainfall-runoff relationships, *Grasslands, *Water yield, *Watershed management, Runoff rates, Hydroelectric power, Reservoirs, Vegetation effects, Maximum flow, Trees, Environmental effects, India, Watershed management, Seasonal variation, Eucalyptus.

Frequency analyses of rainfall and runoff were done at Ootacamund (the Nilgiris) in southern India under conditions of natural grassland and savannah (Shola) land. Availability of water at different probabilities during different months after conversion of natural grasslands into bluegum (eucalyptus) plantations has also been worked out. Investigations revealed that the maximum rainfall occurs during the month of July (298.2 mm at 50% chance) and the minimum is received during January (1.5 mm at 50% chance). On an average, the expected total flow and base flow under natural conditions of grasslands and Shola are 31% and 22% respectively of the expected rainfall of the region. The expected available total flow is maximum (45.8 mm at 50% chance) during the month of August out of which 31.18 mm is contributed by base flow. The minimum expected available water is observed during January-April (the lowest during March). Plantation of bluegum in natural grasslands further reduces water yield by about 23% (at 50% chance) during these months. These reductions in water yield during lean months may affect the water supply into the downstream hydroelectric reservoirs in the region. Hence, caution may have to be exercised while planning large-scale conversion of natural grasslands into bluegum plantations. (See also W89-06463) (Author's abstract)
W89-06464

CALIBRATION, SENSITIVITY AND VALIDATION OF A PHYSICALLY-BASED RAINFALL-RUNOFF MODEL,
Institute of Hydrology, Wallingford (England).
A. Calver.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 103-115, November 15, 1988. 7 fig, 9 ref.

Descriptors: *Calibrations, *Model studies, *Model testing, *Rainfall-runoff relationships, Mathematical models, Mathematical equations, Flow, Surface flow, Storms, Catchment areas, Wales, Simulation, Hydraulic conductivity, Porosity, Hydraulic roughness, Physical properties.

The Institute of Hydrology Distributed Model version 4 is a physically-based rainfall-runoff model using numerical solutions to surface and subsurface flow equations for periods of storm hydrograph generation. Calibration of the model for a small catchment, the Tanllwyth in central Wales, is de-

scribed and an investigation reported into the sensitivity of model simulations to changes in values of key physical variables, namely by hydraulic conductivity, porosity, initial moisture potentials, and surface roughness. The best-fit physical parameter values are transposed temporally to different storm events in the catchment and, in addition, these parameter values are transposed spatially to a physiographically similar adjacent catchment. Confidence in these calibrated physical parameters is enhanced in that they appear valid for the prediction of storm runoff from other rainfall events in the same catchment and have been transposed spatially to a physiographically similar catchment with a fair degree of success. The IHDM work remains a current research project which it is hoped will provide physically realistic runoff simulations for catchments of differing surface characteristics and hydrograph generation processes. (Doria-PTT)
W89-06514

SIMULATION OF PH, ALKALINITY AND RESIDENCE TIME IN NATURAL RIVER SYSTEMS,
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
For primary bibliographic entry see Field 2K.
W89-06696

INTERNATIONAL INVESTIGATIONS OF LARGE-SCALE EVAPORATION,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2D.
W89-06704

FLOOD HYDROLOGY NEAR FLAGSTAFF, ARIZONA,
Geological Survey, Flagstaff, AZ. Water Resources Div.
G. W. Hill, T. A. Hales, and B. N. Aldridge.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225; paper copy $5.25, microfiche $4.00. USGS Water Resources Investigations Report 87-4210, June 1988. 31p, 4 fig, 4 tab, 15 ref.

Descriptors: *Rational formula, *Rainfall-runoff relationships, *Urban hydrology, *Urban runoff, Runoff, Urban areas, Rural areas, Southwestern United States, Flagstaff.

Peak discharges measured at 11 crest-stage gages near Flagstaff were used to determine discharges that have recurrence intervals of 2, 5, 10, and 25 years. The discharges were related to drainage area and urban development in order to provide equations for design of hydraulic structure in the Flagstaff area. Peak discharges in various parts of the city differ considerably. The differences are due to combinations of several drainage-basin characteristics. Coefficients for the rational formula were computed for drainages of less than 10 sq mi. Coefficients for undeveloped rural basins are less than 0.1; coefficients for urban development range from 0.05 to 0.39. This range in values indicates that, with some limitations, coefficients found in general engineering handbooks for urban types of land use are applicable for design in Flagstaff. (USGS)
W89-06886

NATIONAL WATER SUMMARY 1986: HYDROLOGIC CONDITIONS AND GROUNDWATER QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
D. W. Moody, J. E. Carr, E. B. Chase, and R. W. Paulson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225; and Supt. of Documents, GPO, Washington, DC 20402, as S/N 024-001-03564-2, paper copy $36.00. USGS Water-Supply Paper 2325, 1988. 560p, 315 ill, 10 tab.

Descriptors: *Groundwater quality, *Groundwater pollution, *Ambient groundwater quality, *Waste sites, *Groundwater quality management, *United States, *Hydrologic conditions, Radon, Nonpoint-source contamination, Water pollution sources.

This report, fourth of an annual series describing the Nation's water resources, focuses on groundwater quality and summarizes the ambient quality of groundwater in the principal water supply aquifers and describes the nature and extent of groundwater contamination in each State, the District of Columbia, and the territories. Each summary contains multicolor illustrations that show selected geographic features and the 1985 population distribution; the location of principal aquifers and presentation of data related to water quality in those principal aquifers; and the location of selected waste sites, areas of naturally impaired groundwater quality, and areas reflecting human-induced contamination. Also summarized are the State agencies, laws, and regulations involved in groundwater quality management. Other parts of the report: provide a review of significant hydrologic events in the 1986 water year; describe the major factors that control groundwater quality and illustrate by six case studies the ways in which groundwater can become contaminated from point and nonpoint sources and the water quality changes that take place as the contaminants move through the flow system; and discuss the role of the U.S. Environmental Protection Agency and the Federal Government in groundwater protection, and the results of a study of State and local groundwater protection strategies conducted by the National Research Council. A selected listing of chemical and common names of organic compounds referenced in the report and a tabulation of national primary and secondary drinking-water regulations complete the report. (USGS)
W89-06890

MICROCOMPUTER PROGRAM FOR ESTIMATING DROUGHT STREAM-FLOW REDUCTION DUE TO PUMPING FROM NEARBY WELLS,
Georgia Univ., Athens. School of Forest Resources.
J. F. Dowd, P. J. Smith, and K. J. Hatcher.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 202593/AS, Price codes: A04 in paper copy, A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 07-87, July 1987. 56p, 36 fig, 3 tab, 47 ref, 2 append. USGS contract 14-08-0001-G1219. USGS project USGS G121903.

Descriptors: *Surface-groundwater relationships, *Groundwater, *Conjunctive use, *Wells, *Regulation, *Groundwater models, Streamflow, Pumping, Withdrawal, Computer programs, Water management.

A groundwater model for estimating streamflow reductions due to pumping from nearby wells was developed. The model can be used to evaluate well permit applications for groundwater withdrawals. The computer program is based upon an analytical solution of a two-dimensional planimetric representation of a stream/aquifer system in a semi-infinite domain. The variables required are transmissivity, pumping rate, well location, and aquifer storativity. The program calculates drawdown in the aquifer, drawdown adjacent to the stream, amount of flow induced from the stream into the aquifer, and total contribution from the stream into the well for four time steps/simulation. The program runs interactively on IBM-PC-compatible microcomputers. Results are presented through a summary table and high-resolution graphics when hardwater graphics support is available. Output options include line graphs of drawdown along the stream, flow from the stream into the aquifer, and a contour plot of water table drawdown. The report also includes a sensitivity analysis of the computer program for ranges of data likely to be encountered in the southeastern coastal plain. The results illustrate the relative influence of each input parameter and highlight critical data needs for permit evaluation. The results indicate that for many combinations of field conditions and sustained pumping, 90% or more of the total well withdrawal is derived from nearby streams. (Dowd-GA U.)
W89-06894

NONLINEAR APPROACH TO THE DETERMINATION OF RESERVOIR OPERATING RULES,
Purdue Univ., Lafayette, IN. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-06924

HYDROLOGY OF THE OKEFENOKEE SWAMP WATERSHED WITH EMPHASIS ON GROUNDWATER FLOW,
Georgia Univ., Athens. Graduate School.
For primary bibliographic entry see Field 2F.
W89-06925

2B. Precipitation

GRID-BASED APPLICATION OF RUNOFF CURVE NUMBER,
Pennsylvania State Univ., University Park. Dept. of Geography.
For primary bibliographic entry see Field 2E.
W89-05816

LOW LATITUDE INFLUENCE ON WINTER RAINFALL IN VICTORIA, SOUTH-EASTERN AUSTRALIA: II. RELATIONSHIPS WITH THE SOUTHERN OSCILLATION AND AUSTRALIAN REGIONAL CIRCULATION,
Melbourne Univ., Parkville (Australia). Dept. of Meteorology.
W. J. Wright.
Journal of Climatology JOUCDU, Vol. 8, No. 6, p 547-576, November-December 1988. 14 fig, 3 tab, 89 ref.

Descriptors: *Australia, *Southern oscillation, *Seasonal distribution, *Rainfall, *Atmospheric circulation, *Climatology, Latitude, Cloud cover, Atmospheric pressure.

Northern Victorian winter rainfall variability is dominated by 'interacting' (I) fronts; both parameters are related to atmospheric circulation anomalies in the Australian region and the Southern Oscillation. The major circulation features accompanying extreme wet and dry winter months in northern Victoria are identified from composited sea level pressure, 500 hPa height, and 200 hPa wind fields. Wet winters are characterized by a vigorous subtropical westerly circulation at middle and upper tropospheric levels, a relatively weak subtropical high pressure belt over Australia, and above normal amplitude of the climatological mean long-wave trough in western Australian longitudes. The intensity and frequency of I frontal systems influencing southeastern Australia is strongly related to these features and to cloudiness over the tropical Indian Ocean northwest of Australia, a major source-region for cloudbands involved in the interactions. In turn, above-normal trough amplitude and cloudiness, a weak subtropical high pressure belt, and frequent and relatively well-developed interactions, all are shown to be characteristic of winters in with the Tahiti-Darwin Southern Oscillation Index (SOI) is positive. Anomalies tend to be in the opposite sense during negative SOI winters, which feature infrequent, generally poorly developed, interactions, and much lighter rainfall. The dual association of these circulation and cloudiness features with both the SOI and northern Victorian rainfall strongly suggests that I fronts provide the link between SOI and northern Victorian rainfall. The results are discussed in relation to synoptic associations and anomalous heat sources. (Author's abstract)
W89-05831

SOUTHERN OSCILLATION AND SOUTH AFRICAN SUMMER RAINFALL,
Weather Bureau, Pretoria (South Africa).
J. Van Heerden, D. E. Terblanche, and G. C. Schulze.
Journal of Climatology JOUCDU, Vol. 8, No. 6, p 577-797, November-December 1988. 8 fig, 3 tab, 43

ref.

Descriptors: *Drought, *Climatology, *South Africa, *Southern oscillation, *Seasonal distribution, *Rainfall, *Atmospheric circulation, *El Nino, Climatology, Latitude, Atmospheric pressure, Temporal variability, Spatial variability.

Using data since 1882, the relationship between summer rainfall over South Africa and the El Nino/Southern Oscillation (ENSO) phenomenon was investigated. There is a strong association between Warm Events and dry spells, and between Cold Events and wet spells. The temporal and spatial variability in the relationship is presented. Rainfall during December and March correlates significantly with the previous winter's Southern Oscillation (SO) Index, but rainfall during the mid-summer months, January and February, shows much weaker correlation. A significant relationship was detected between the summer rainfall and mean monthly geopotentials as well as the 850-500 hPa thermal wind over the central parts of South Africa. Distinctions are made between the dominant rain-producing systems with regard to these parameters. During January and February, when the SO/rainfall relationship is fairly weak, rainfall develops in a predominantly quasi-barotropic circulation. During December and March the most significant SO/rainfall correlation coincides with a shift to baroclinic systems. Analysis suggests that a clear signal of the SO can be observed in the phase and amplitude of summertime synoptic-scale baroclinic systems over the South African region. (Author's abstract)
W89-05832

HYDROLOGICAL PERSISTENCE CHARACTERISTICS OF FLOODS AND DROUGHTS: INTERREGIONAL COMPARISONS,
Yamanashi Univ., Kofu (Japan). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 2A.
W89-05843

TECHNOLOGICAL DEVELOPMENTS IN REAL-TIME OPERATIONAL HYDROLOGIC FORECASTING IN THE UNITED STATES,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 2E.
W89-05844

HYDROLOGIC SAMPLING: A CHARACTERIZATION IN TERMS OF RAINFALL AND BASIN PROPERTIES,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7A.
W89-05846

EFFECT OF STORM RAINFALL INTENSITY PATTERNS ON SURFACE RUNOFF,
Agricultural Research Service, Tucson, AZ. Arid-land Watershed Management Research Unit.
For primary bibliographic entry see Field 2A.
W89-05858

EVALUATION OF RAINFALL-RUNOFF MODELS FROM THE STOCHASTIC VIEWPOINT,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05860

SIMPLE WATER BALANCE DAILY RAINFALL-RUNOFF MODEL WITH APPLICATION TO THE TROPICAL MAGELA CREEK CATCHMENT,
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
For primary bibliographic entry see Field 2E.
W89-05885

MODELLING LONG TERM STREAM ACIDIFICATION TRENDS IN UPLAND WALES AT PLYNLIMON,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W89-05890

MODELLING RAINFALL/WATERTABLE RELATIONS USING LINEAR RESPONSE FUNCTIONS,
Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental Unit.
A. C. Armstrong.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 383-389, October-December 1988. 6 fig, 13 ref.

Descriptors: *Infiltration, *Model studies, *Groundwater recharge, *Mathematical models, *Rainfall, *Water table, Linear system theory, Model drainage, Unit hydrographs, Clays, Loam, Drainage.

Linear system theory can be used to model and predict watertable responses to precipitation inputs in an artificially drained field. The response function is mathematically equivalent to the Unit Hydrograph concept familiar to hydrologists. Under constant soil properties, the form of the response function can be anticipated to reflect the efficiency of the drainage system in removing water. Response functions then offer a potential tool for the comparison of the efficiency of differing drainage installations, or for monitoring the declining efficiency over a number of years of the drainage system, particularly mole drainage, in a way that is independent of the particular weather sequences experienced. Comparative results were obtained from two sites with very different soil physical conditions: (1) a clay soil of the Hallsworth series where mole drains have been used to control the watertable; and (2) a deep sandy loam soil of the Agney series, drained by pipes alone at spacings of 20 m at depths of 120 cm. The response function derived from the sandy loam shows several features which distinguish it from those from clay. Firstly, it has more strongly marked oscillations, which appear to reflect the behavior of the soil system in smoothing the rainfall inputs. Secondly, there is a considerable delay in reaching the peak, which is close to 32 hours, with a 12 hour delay in reaching any response. Thirdly, the overall form of the response function is very much flatter than that from the clay, reflecting the higher porosity of this soil. This second set of results confirms that the technique is applicable to other sites, and that the derived response function is sensitive to changes in site conditions. (Brock-PTT)
W89-05892

APPLICATION OF KRIGING TO RAINFALL NETWORK DESIGN,
Pittsburgh Univ., PA.
For primary bibliographic entry see Field 7A.
W89-05900

ANALYSES OF 1-MIN RAIN RATES EXTRACTED FROM WEIGHING RAINGAGE RECORDINGS,
Air Force Geophysics Lab., Hanscom AFB, MA.
P. Tattelman, and R. W. Knight.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 8, p 928-938, August 1988. 9 fig, 4 tab, 9 ref.

Descriptors: *Statistical analysis, *Frequency analysis, *Rain gages, *Rainfall rate, *Meteorological data collection, Measuring instruments, Data processing, Probability distribution, Variability.

One-minute rain rates can be effectively extracted for long periods of time at locations for which weighing raingage recordings are available. The method described employs magnification of original chart records with modern digitizing and filtering techniques to obtain the 1-min data that are ordinarily unreadable. Analyses of the frequency and duration of 1-min rain rates for a 10-year period of record is provided for Boston, Denver, Grand Junction, Key West, Omaha, Rapid City, Seattle and Urbana. Particular attention is given to the frequency and probability of 1-min rates with durations of 1, 5, 10, 15, 20 and 30 min. Results show the high variability of the frequency versus duration and rainfall rate for midseason months at most locations. Variability is least for Key west and Seattle where rates are high and low, respectively, during each of the months. A study of the time between rainfall events is also provided for three locations: Boston, Key West and Urbana. (Sand-PTT)
W89-05903

INFLUENCE OF LAND SURFACE ROUGHNESS ON ATMOSPHERIC CIRCULATION AND PRECIPITATION: A SENSITIVITY STUDY WITH A GENERAL CIRCULATION MODEL,
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
Y. C. Sud, J. Shukla, and Y. Mintz.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 9, p 1036-1054, September 1988. 13 fig, 1 tab, 24 ref. National Science Foundation Grants ATM-8309767 and ATM-0153818; NASA Grant NAG5-383.

Descriptors: *Geomorphology, *Model studies, *Meteorology, *Atmospheric circulation, *Air circulation, *Precipitation, *Rainfall distribution, Simulation, Wind velocity, Evaporation, Heat flux, Water vapor transport, Sensitivity.

The influence of land surface roughness on the large scale atmospheric circulation and rainfall was examined by comparing three sets of simulations made with a general circulation model in which the land surface roughness length was reduced from 45 cm to 0.02 cm. The reduced surface roughness produced a 2-fold increase in the boundary layer wind speed and, at the same time, a 2-fold decrease in the magnitude of the surface stress. There was almost no change in the surface evaporation and surface sensible heat flux. There was a large change in the horizontal convergence of the water vapor transport in the boundary layer and a corresponding large change in the rainfall distribution mainly as a consequence of the change in the curl of the surface stress. This result suggests that the height of the earth's vegetation cover, which is the main determinant of the land surface roughness, has a large influence on the boundary layer water vapor transport convergence and the rainfall distribution. (Author's abstract)
W89-05904

PARAMETERIZATION OF THE EVAPORATION OF RAINFALL,
Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
M. E. Schlesinger, J.-H. Oh, and D. Rosenfeld.
Monthly Weather Review MRWEAB, Vol. 116, No. 10, p 1887-1895, October 1988. 6 fig, 24 ref. NSF and DOE Grant ATM-8511889.

Descriptors: *Rainfall rate, *Evaporation rate, *Mathematical analysis, *Meteorology, South Africa, Humidity, Clouds, Convective precipitation.

This study develops theoretical expressions for the rainfall rate, P(z), and the total evaporation rate, E(z), from cloud base to a level z below cloud base. The resultant parameterization for the total evaporation is given by E(z) = C times (P(0) to the alpha power) times psi(z), where P(0) is the rainfall rate at cloud base, alpha and C are undetermined parameters, and psi(z) is a function of z determined for the cases of constant relative humidity and constant absolute humidity below cloud base which correspond approximately to stratiform and cumuloform clouds, respectively. The parameters alpha and C are determined from radar observations of the rain falling from continental convective cells in central South Africa. The resultant values are alpha = 0.606 and C = .0263 for P(0) and E(z) in millimeters per hour. Subsequent analyses of other radar observations utilizing the method developed in this study are needed to obtain corresponding evaporation parameterization for cumuloform precipitation in other climatic regimes and for stratiform precipitation. (Author's abstract)

W89-05908

HYDROLOGICAL AND CHEMICAL INPUTS TO FIR TREES FROM RAIN AND CLOUDS DURING A 1-MONTH STUDY AT CLINGMANS PEAK, NC,
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W89-05915

RAINFALL ENHANCEMENT OVER THE HAWAIIAN ISLANDS,
Hawaii Univ., Honolulu. Dept. of Geography.
D. Nullet, and M. McGrahaghan.
Journal of Climate JCLEL, Vol. 1, No. 8, p 837-839, August 1988. 1 fig, 1 tab, 5 ref.

Descriptors: *Orographic precipitation, *Rainfall distribution, *Hawaiian Islands, Maps, Marine climate, Trophic regions.

Recently compiled rainfall maps for the Hawaiian Islands were analyzed to determine by what ratio a tropical high island increases rainfall over open ocean values. The results show a ratio of island rainfall to oceanic rainfall ranging from 3.4 on Kauai to 0.8 on Lanai when an oceanic rainfall value of 700 mm is used. The most important sources of variation in this ratio appear to be the shape of the island and the rain shadow effect. (Sand-PTT)
W89-05920

WET DEPOSITION ESTIMATES FROM LONG-TERM BULK AND EVENT WET-ONLY SAMPLES OF INCIDENT PRECIPITATION AND THROUGHFALL,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
D. D. Richter, and S. E. Lindberg.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 619-622, October-December 1988. 1 fig, 2 tab, 22 ref. Electric Power Res. Inst. (RP-1813-1; RP-1907-1) Office of Health and Environ. Res., Dept. of Energy, Contract DE-AC05-84OR21400.

Descriptors: *Sampling, *Chemistry of precipitation, *Air pollution, *Precipitation, *Forests, *Throughfall, Canopy, Cycling nutrients, Sulfates, Nitrates, Calcium, Potassium, Hydrogen ion concentration, Seasonal variation, Oak trees.

This 2-yr study compares two sampling systems that are used to measure ionic constituents in incident precipitation and canopy throughfall: long-term bulk sampling vs. event-based, wet-only sampling. Major deviations in chemical concentrations (SO4(--), NO3(-), K(+), Ca(2+) and H(+)) were documented between the two sampling systems, deviations that were ion-specific in both incident precipitation and throughfall. Differences in chemical concentrations between the two sampling systems were greater (i) during the growing than during the dormant seasons, and (ii) for incident precipitation (collected in the open) than for throughfall under chestnut oak forest (Quercus prinus) canopies. Nutrient-cycling processes in forests may be misinterpreted if flux data are based solely on long-term bulk samplers of incident precipitation and canopy throughfall. For example, comparison of bulk and wet-only throughfall solutions suggests that when bulk samplers collect throughfall under hardwood canopies, the ability of hardwood canopies to increase pH of low pH precipitation may be overestimated. (Author's abstract)
W89-05934

IMPACT OF SOURCE CONTROLS ON ACID RAIN LEVELS,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-05954

RARE AUGUST RAINFALL EVENT IN ANDALUCIA,
Manchester Univ. (England). Dept. of Geography.
D. G. Tout.
Weather WTHRAL, Vol. 43, No. 10, p 350-355, October 1988. 3 fig, 1 tab, 5 ref.

Descriptors: *Spain, *Meteorology, *Rainstorms, Synoptic analysis, Meteorology, Seasonal variations, Rainfall impact, Agriculture, Urban drainage, Model studies, Soil erosion.

The synoptic situation associated with an infrequent rainfall event, which took place in late August 1987 in Andalucia (southern Spain), is analyzed. A cut-off cold low, which developed in a cold trough over Iberia, produced rainfalls of 135 mm at Gilbraltar and almost 100 mm in parts of Andalucia. The torrential rain moved northwards and eastwards through western Andalucia, which bore the brunt of the very unseasonal weather. Clearly, rainfall in August, of this intensity, does more harm than good in Andalucia. The urban infrastructure is unable to cope with a meteorological event of this magnitude and agriculture does not benefit from such unseasonal rainfall, which by its very intensity will flatten many of the crops and contribute to soil erosion rather than to replenishment of the water-table. In addition, this type of rainfall event causes disruption to transportation in the area. Developments in the middle troposphere are more significant than surface developments and the synoptic situation responsible for storms of this type is more pronounced on the 500 mbar contour chart than the surface synoptic chart, where the low may appear insignificant and little different from the thermal low normally found in the summer months. Numerical models should be able to predict, several days in advance, the development of the larger scale synoptic patterns which cause severe summer weather. (Miller-PTT)
W89-05956

WEATHER INPUT FOR NONPOINT-SOURCE POLLUTION MODELS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W89-05963

IMPROVING PROJECTED POTENTIAL EVAPOTRANSPIRATION ESTIMATES USING NATIONAL WEATHER SERVICE FORECASTS,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
For primary bibliographic entry see Field 2D.
W89-06002

PRODUCTION OF CLOUD CONDENSATION NUCLEI IN MEXICO CITY,
Universidad Nacional Autonoma de Mexico, Mexico City. Lab. de Energia solar
J. R. Herrera, and J. J. Castro.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 10, p 1189-1192, October 1988. 3 fig, 1 tab, 21 ref.

Descriptors: *Cloud physics, *Condensation, *Nucleation, *Air pollution effects, *Mexico City, Meteorology, Aerosols, Climate, Weather patterns, Supersaturation.

A long-term program oriented toward understanding the influence of air pollution on weather and climate in Mexico City is discussed. As the first step, hourly variations of the atmospheric aerosol concentration active as cloud condensation nuclei was measured at supersaturation of 0.75. The tests were performed at ground level using a horizontal thermal diffusion chamber from April 1 to April 5 1984. The results showed a pattern characterized by a maximum of cloud condensation nuclei with values between 6500 and 3500 cloud condensation nuclei cu cm during the first hours of sunlight, until the concentration reaches values fluctuating between 2000 and 600 cloud condensation nuclei/cu cm during the afternoon. Analysis of the results shows how the interplay of anthropogenic sources and local meteorological conditions determine a characteristic pattern of cloud condensation nuclei concentration. (Author's abstract)
W89-06003

RESPONSE OF HEADWATER LAKES TO VARYING ATMOSPHERIC DEPOSITION IN NORTH-CENTRAL ONTARIO, 1979-85,
Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
For primary bibliographic entry see Field 5C.
W89-06376

ACIDIC CLOUD WATER AND CATION LOSS FROM RED SPRUCE FOLIAGE,
Tennessee Valley Authority, Muscle Shoals, AL. Air Quality Branch.
For primary bibliographic entry see Field 5C.
W89-06392

DIFFERENCES BETWEEN NEW ENGLAND COASTAL FOG AND MOUNTAIN CLOUD WATER CHEMISTRY,
Appalachian Mountain Club, Gorham, NH. Research Dept.
For primary bibliographic entry see Field 5B.
W89-06395

PRACTICAL GENERATION OF SYNTHETIC RAINFALL EVENT TIME SERIES IN A SEMI-ARID CLIMATIC ZONE,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
J. J. Bogardi, L. Duckstein, and O. H. Rumambo.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 357-373, November 30, 1988. 8 fig, 9 tab, 9 ref.

Descriptors: *Mathematical models, *Rainfall frequency, *Depth-area-duration analysis, *Tanzania, *Semiarid climates, *Time series analysis, Computer models, Convective precipitation.

An event-based approach adapted to semi-arid climatic conditions and applicable in those cases when only unreliable observation data are available is developed. Emphasis is placed on ease of modeling and computation. The case study of a 20,000 sq km area in Central Tanzania where rainfall is mostly from convective-type storms is used to illustrate the approach. A phenomenological description of both convective-storm and frontal system precipitation is provided by a regional study of point rainfall events defined as an uninterrupted succession of days with more than 5 mm of precipitation, and dry events defined as a succession of dry days. The rainfall events are defined by depth and duration, which are found to be correlated. An analysis of the depth per event is thus performed, conditioned on the event duration. The log Pearson type III distribution appears to provide a good overall fit for the depth per event, especially for events lasting more than one day, while the one-day long events fit the negative binomial distribution. The event duration is found to fit a geometric distribution. The dry events during the rainy season seem to fit a negative binomial distribution. The climatic cycle length is fitted to a log Pearson type III distribution. A step-by-step procedure provided herein to simulate regional rainfall can easily be implemented on a microcomputer or even a programmable hand calculator. (Author's abstract)
W89-06465

CLIMATE-BASED REPRESENTATIONS OF SUMMER RAINFALL IN ILLINOIS,
Illinois State Water Survey Div., Champaign. Climatology and Meteorology Section.
For primary bibliographic entry see Field 3B.
W89-06467

SPATIAL DEPENDENCE OF THE RELATIONSHIP BETWEEN RAINFALL AND OUTGOING LONGWAVE RADIATION IN THE TROPICAL ATLANTIC,
Maryland Univ., College Park. Dept. of Meteorology.
For primary bibliographic entry see Field 7B.

W89-06468

SAMPLING ERROR STUDY FOR RAINFALL ESTIMATE BY SATELLITE USING A STOCHASTIC MODEL,
Texas A and M Univ., College Station. Coll. of Geosciences.
For primary bibliographic entry see Field 7B.
W89-06479

SINGLE THRESHOLDING AND RAIN AREA DELINEATION FROM SATELLITE IMAGERY,
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
For primary bibliographic entry see Field 7B.
W89-06480

NUMERICAL SIMULATION OF THE 1981 SICHUAN FLOOD: PART I. EVOLUTION OF A MESOSCALE SOUTHWEST VORTEX,
National Center for Atmospheric Research, Boulder, CO.
Y. H. Kuo, L. Cheng, and J. W. Bao.
Monthly Weather Review MRWEAB, Vol. 116, No. 12, p 2481-2504, December 1988. 20 fig, 1 tab, 33 ref.

Descriptors: *Meteorology, *Simulation analysis, *Weather patterns, *Weather forecasting, *Rainfall, *Flood forecasting, *Vortices, *China, Mathematical models, Precipitation, Sensitivity analysis, Monsoons, Topography, Numerical analysis, Latent heat, Heat flow, Cyclonic precipitation, Friction, Weather forecasting, Weather patterns, Air circulation, Atmospheric physics, Simulation.

Mesoscale analyses of the 11-15 July 1981 floods in the Sichuan Basin of China showed that they were directly related to the development of a long-lived mesoscale southwest (SW) vortex over the basin. Numerical experiments were performed to test the capability of a limited-area mesoscale model to predict the evolution of the SW vortex and the accompanying heavy precipitation, to examine the structure of the simulated vortex using the model data, and to elucidate the role of various physical processes in the evolution of the SW vortex. The control experiment was able to simulate the evolution of the mesoscale SW vortex and the accompanying heavy precipitation. The SW vortex formed completely within the southwesterly monsoon current, remote from the baroclinic frontal system to the north. Latent heat release was essential for the development of the SW vortex and the resulting precipitation. Surface sensible and latent heat fluxes were important to the precipitation forecast. Further sensitivity experiments showed that the SW vortex observed in this case was a terrain-induced standing eddy. The differential frictional effect, hypothesized over the past decade to be a plausible mechanism for the formation of the SW vortex, was shown to be unimportant in this case. The surface friction acted as both a vorticity sink and an energy sink. When it was removed, the SW vortex evolved sooner with considerably stronger intensity. A trajectory diagnosis and a model experiment with modified topography showed that as the southwesterly monsoon current impinged upon the mesoscale Yun-Gui Plateau, which extends from the southeastern corner of the main Tibetan Plateau, the low-level flow was blocked. The flow aloft then descended into the Sichuan Basin on the lee side of the mesoscale plateau, creating cyclonic relative vorticity over the basin by stretching of earth's background vorticity. This explains why the Sichuan Basin is a climatically favorable location for the origin of the SW vortex. (Author's abstract)
W89-06485

CLIMATOLOGICAL VARIABILITY OF SULFUR DEPOSITIONS IN EUROPE,
Environmental Protection Agency, Washington, DC. Office of Air and Radiation.
B. L. Niemann.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 79-94, 1988. 10 fig, 5 tab, 17 ref.

Descriptors: *Air pollution, *Climatology, *Acid rain, *Sulfur, *Europe, *Deposition, *Model studies, Water pollution sources, Air temperature, Precipitation, Meteorological data collection, Soviet Union, Model testing, Wind.

The climatological variability in historical and projected sulfur deposition levels for Europe have been simulated using a simple source-receptor model (RCDM) that runs on a personal computer using an extended period of wind and precipitation data. The variability in historical temperature and precipitation data has been analyzed to assess the representativeness of the limited meteorological period used in the EMEP model (1978-1982). A match-up between 40 selected EMEP (European Monitoring and Evaluation Programme)monitoring sites and the closest climatological station showed that 5-yr average for the EMEP period (1978-1982) and the 35-yr precipitation amounts in generally good agreement for the majority of sites. Comparisons between the RCDM model simulations using the International Institute for Applied Systems Analysis (IIASA) base 1980 SO2 emissions and the 1978-1982 average precipitation amounts showed the model predictions were generally within a factor of two of the EMEP concentrations and depositions at 40 selected sites. The sensitivity of model evaluation results to free parameter tuning and the appropriateness of the resulting free parameters requires more analysis. The total sulfur depositions at the IIASA receptors predicted by the RCDM model under base year 1980 emissions showed very small differences between the predicted total sulfur depositions for the 1978-1982 EMEP period and the 1951-1985 normal period. The long-period variability in annual total sulfur depositions simulated by the RCDM with constant emissions showed the largest fluctuations in the mid-1970s and showed that the means and C.V.s were not significantly different between the time periods of interest. It is recommended that additional source areas for the Soviet Union be added to the model and the sensitivity to country emission and area centroid locations be explored. (Author's abstract)
W89-06486

ASSESSMENT OF IMPACTS OF POSSIBLE CLIMATE CHANGES ON THE RESULTS OF THE IIASA RAINS SULFUR DEPOSITION MODEL IN EUROPE,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 5B.
W89-06487

ANNUAL MONITORING OF RAINWATER SULPHATE IN AN URBAN ZONE OF ROME (ITALY),
Istituto Superiore di Sanita, Rome (Italy). Lab. di Igiene del Territorio.
For primary bibliographic entry see Field 5B.
W89-06492

INTERANNUAL VARIABILITY OF WINTER MEAN PRECIPITATION AND UPPER-LEVEL CIRCULATION IN EXTENDED GCM INTEGRATIONS WITH AND WITHOUT INTERANNUAL VARIATION OF TROPICAL PACIFIC SST,
Seoul National Univ. (Republic of Korea). Dept. of Atmospheric Sciences.
I.-S. Kang.
Journal of the Meteorological Society of Japan JMSJAU, Vol. 66, No. 5, p 741-751, October 1988. 12 fig, 23 ref.

Descriptors: *Meteorological data collection, *Climatology, *Precipitation, *Model studies, *Water temperature, *Tropical regions, Temporal distribution, Eddies, Surface water.

Interannual variations of winter mean precipitation and upper-tropospheric stationary eddy and the influence of tropical sea surface temperature (SST) on their variability are investigated. Data are obtained from a series of 15-year general circulation model (GCM) integrations with (the 'SST runs') and without (the 'control run') interannual variations of tropical Pacific SST observed during a 15-year period. The fluctuation of tropical Pacific SST accounts for a large fraction of precipitation variability in localized tropical regions, and the variability of upper-level stationary eddy over the subtropical central Pacific in both hemispheres. The east-west seesaw between fluctuations of precipitation over the equatorial central Pacific (cp) and the tropical western Pacific (wp) and the induced anomalous Walker circulation owe their existence mainly to the SST fluctuation over cp. Both precipitation anomalies over cp and wp in the SST runs induce the circulation anomaly in the Pacific/North America (PNA) region, but the stronger response results from the precipitation anomaly over cp. Among the tropical regions, the central Pacific is the region where SST has the strongest impact on the large-scale fluctuations of tropical precipitation and midlatitude circulation over the PNA sector. In the control run, however, tropical precipitation anomalies over cp and wp do not result in any organized large-scale circulation pattern in the midlatitudes. (Author's abstract)
W89-06537

ROLE OF FRONTOGENETICAL FORCING AND CONDITIONAL SYMMETRIC INSTABILITY IN THE MIDWEST SNOWSTORM OF 30-31 JANUARY 1982,
Saint Louis Univ., MO. Dept. of Earth and Atmospheric Sciences.
J. T. Moore, and P. D. Blakley.
Monthly Weather Review MRWEAB, Vol. 116, No. 11, p 2155-2171, November 1988. 19 fig, 20 ref.

Descriptors: *Meteorology, *Snow, *Storms, *Weather patterns, Precipitation, Rainfall, Rainfall intensity, Convection, Satellite technology.

Frontogenetical forcing together with conditional symmetric instability are discussed as possible physical explanations for the intense precipitation of the Midwest snowstorm of January 30-31, 1982. It is shown that moderate-strong ascent was part of a thermally direct ageostrophic circulation created by frontogenetical forcing. Frontogenesis is shown both at the surface and aloft to increase in the 12-hour period prior to the heavy precipitation. It is strongest in the low levels and slopes to the west-northwest with height along an advancing cold frontal zone. Both deformation and divergence components of the frontogenetical function equation play key roles in the total frontogenesis. Quasi-geostrophic frontogenesis is also shown to be quite strong, especially at low levels. Q-vector forcing of vertical motion increased with the quasi-geostrophic frontogenesis and helped create a direct thermal circulation of warm air rising in south-central Missouri-Illinois and cool air sinking in northern portions of those states normal to the axis of maximum frontogenetical forcing. Conditional symmetric instability was also diagnosed in the region of the updraft of the direct thermal circulation. This 'slantwise convection,' diagnosed where surfaces of constant geostrophic angular momentum slope less than surfaces of equivalent potential temperature, is believed to have both increased the intensity of the updraft and decreased the scale length of the phenomena. The conditional symmetric instability may have helped to create pulselike eruptions of elevated cloud tops seen in satellite imagery and often noted with East Coast cyclogenesis by several researchers. (Author's abstract)
W89-06538

SUPERCOOLED WARM RAIN PROCESS AND THE SPECIFICATION OF FREEZING PRECIPITATION,
Maryland Univ., College Park. Dept. of Meteorology.
For primary bibliographic entry see Field 2C.
W89-06539

DEVELOPMENT AND LIFE CYCLE OF THE INDIAN MONSOON: EFFECT OF THE 30-50 DAY OSCILLATION,
Iowa State Univ., Ames. Dept. of Earth Sciences.
T.-C. Chen, R.-Y. Tzeng, and M.-C. Yen.
Monthly Weather Review MRWEAB, Vol. 116, No. 11, p 2183-2199, November 1988. 11 fig, 27 ref.

NSF Grant ATM-8611476.

Descriptors: *Monsoons, *India, *Climatology, Wind, Weather, Mathematical studies.

The velocity-potential fields generated from the FGGE III-b horizontal winds of the European Centre for Medium Range Weather Forecasts were subjected to an empirical orthogonal function (EOF) analysis to extract the annual cycle and the 30-50 day mode of the divergent circulations. It was found that the Indian monsoon circulation is portrayed by the annual cycle of the divergent circulation and develops as a classical, giant sea-breeze model. On the other hand, this monsoon system is modulated by the planetary-scale 30-50 day low-frequency mode to establish an onset-break-revival-retreat life cycle. This modulation is accomplished through the following interaction processes. The northeastward propagation of the planetary-scale 30-50 day mode over the Indian monsoon region induces transient local Hadley circulation. Through this type of circulation, the planetary-scale 30-50 day mode couples with and steers northward the low-level, 30-50 day monsoon troughs and ridges that originated around the equator. The northward migration of these low-level transient troughs and ridges cause, respectively, the deepening and filling of the monsoon trough over central India. The evolution of this monsoon trough results in the intensification and weakening of the Indian monsoon and its life cycle. (Author's abstract)
W89-06540

SATELLITE-OBSERVED CHARACTERISTICS OF MIDWEST SEVERE THUNDERSTORM ANVILS,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
G. M. Heymsfield, and R. H. Blackmer.
Monthly Weather Review MRWEAB, Vol. 116, No. 11, p 2200-2224, November 1988. 18 fig, 5 tab, 33 ref.

Descriptors: *Remote sensing, *Thunderstorms, *Satellite technology, *Infrared imagery, *Model studies, Weather, Clouds, Temperature, Statistical analysis.

Analyses are presented of the cloud top and anvil structure of severe thunderstorms as observed by the Geostationary Operational Environmental Satellite (GOES) infrared imagery for five SESAME cases during 1979 and four non-SESAME cases during 1980-82. The combination of strong tropospheric shear, especially near the tropopause level, intense updrafts, and overshooting tops appear to be an important ingredient in the V development. Severe weather and the V feature are strongly correlated because both are associated with strong updrafts and large tropospheric shear, although the former has especially strong shear at low to mid-levels, while the latter is associated with large shear at the tropopause level. A conceptual model is presented in which the close-in warm point is produced by both internal cloud air motions and stratospheric flow around and over the cloud top. Calculations with a horizontal two-dimensional kinematic model are discussed to provide insight on anvil sizes and orientations. The observed and modeled anvil orientations were found to be parallel to the storm relative winds at upper-levels. The modeled anvil width was found to be related to the vertical mass flux in the updrafts, the anvil thickness, and the anvil-level relative wind speed. (Author's abstract)
W89-06541

GCM SIMULATION STUDY OF THE INFLUENCE OF SAHARAN EVAPOTRANSPIRATION AND SURFACE-ALBEDO ANOMALIES ON JULY CIRCULATION AND RAINFALL,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
Y. C. Sud, and A. Molod.
Monthly Weather Review MRWEAB, Vol. 116, No. 11, p 2388-2400, November 1988. 10 fig, 2 tab, 33 ref.

Descriptors: *Sahara, *Evapotranspiration, *Albedo, *Rainfall, *Hydrologic cycle, *Atmospheric physics, *Model studies, Simulation, Vegetation, Semiarid climates, Soil water, Evaporation, Rain, Climatology, Boundary conditions, Convection.

The GLA (Goddard Laboratory for Atmospheres) GCM (general circulation model) was employed in three experiments to investigate the influence of surface albedo and evapotranspiration anomalies that could result from the hypothetical semiarid vegetation over North Africa (including the Sahara desert) on its July circulation and rainfall. The results of the first experiment show that the increased soil moisture and its dependent evapotranspiration produces a cooler and moister planetary boundary layer (PBL) over North Africa that is able to support enhanced moist convection and rainfall in Sahel and southern Sahara. The results of the second experiment show that the lower surface albedo yields even higher moist static energy in the PBL and further enhances the local moist convection and rainfall. The third experiment, with the modified rain-evaporation parameterization, produces hydrological cycle and accompanying rainfall anomalies that were quite similar to those of the second experiment specifically over the anomaly region; however, some differences between the second and third experiments were evident in distant regions. These differences suggest the importance of a different and/or a better parameterization of falling rain. (Author's abstract)
W89-06542

AIR POLLUTION AND ACID RAIN: THE BIOLOGICAL IMPACT,
Lancaster Univ. (England).
For primary bibliographic entry see Field 5B.
W89-06630

SUBSYNOPTIC ENVIRONMENT ASSOCIATED WITH TWO INTERMOUNTAIN SEVERE THUNDERSTORM EVENTS,
Battelle Pacific Northwest Labs., Richland, WA.
M. N. Schwartz, and G. L. Andrews.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000551. Price codes: A03 in paper copy, A01 in microfiche. Report No. PNL-SA--13326, July 1985. 46p, 12 fig, 13 ref. DOE Contract DE-AC06-76RL0 1830.

Descriptors: *Synoptic analysis, *Meteorology, *Meteorology, *Thunderstorms, *Mountains, Storms, Radiation, Convection, Air temperature, Orography, Nevada, Washington, Oregon, Weather patterns, Cooling, Satellite technology, Lighting.

Two severe thunderstorm events affecting the intermountain region of the Pacific Northwest on April 23 and April 30, 1981, were analyzed using quasi-horizontal isentropic surfaces and vertical cross sections. These events developed from similar synoptic and subsynoptic environments. The 1200 GMT isentropic analyses revealed two thermal ridges: one located west of the Cascades and the other located over the Great Basin of Nevada. The thermal ridge west of the Cascades moved eastward during the morning hours above the radiation inversion in eastern Washington. This warm air acted as a stabilizing layer, which suppressed convection throughout the day. The warm air associated with the thermal ridge in the Great Basin mixed to the surface during the day because of the strong insolation and diabatic processes. A horizontal potential temperature gradient (thermal line) formed at the surface in southeastern Oregon between warm modified Pacific air to the north and hot continental air to the south. The initial convection formed solely in central Oregon in the vicinity of the thermal line and its attendant cyclonic circulation. This convection was well to the south and east of the salient surface features, the thermal low, and the Pacific cold front. As the cells matured, they moved northeastward toward the Columbia Basin, and area undergoing thermodynamic destabilization because of the influx of cooler, drier air in the midlevels associated with a trough advancing from the eastern Pacific Ocean. The cells reached estimated heights between 12 and 15 km and had cloud-top temperatures between -60 C and -70 C as assessed by satellite imagery. Strong winds, heavy rain, hail, and copious lightning occurred as the cells formed into a mesoscale-type complex and progressed across the Columbia Basin toward Idaho and Montana. (Author's abstract)
W89-06649

PROBABLE MAXIMUM PRECIPITATION ESTIMATES-UNITED STATES BETWEEN THE CONTINENTAL DIVIDE AND THE 103RD MERIDIAN,
National Weather Service, Silver Spring, MD. Office of Hydrology.
E. M. Hansen, D. D. Fenn, L. C. Schreiner, R. W. Stodt, and J. F. Miller.
Hydrometeorological Report No. 55A, June 1988. 242p, 113 fig, 25 tab, 44 ref, 3 append; 6 plates in a supplemental envelope.

Descriptors: *Probable maximum precipitation, *Weather patterns, *Weather forecasting, *Prediction, Orography, Precipitation, Estimating, Storms, Drainage area.

This study provides all-season general-storm probable maximum precipitation (PMP) estimates for durations from 1 to 72 hr for the region between the Continental Divide and the 103rd meridian. For the nonorographic portions of eastern Montana, Wyoming, North and South Dakota, Colorado, New Mexico and western Texas for area sizes estimates are available from 10 to 20,000 sq mi. For orographic regions of these states east of the Continental Divide estimates are available for area sizes from 10 to 5,000 sq mi. The study also provides estimates of local-storm PMP for the region. These estimates cover durations from 15 minutes to 6 hours and drainage areas between 1 and 500 sq mi. A step-by-step procedure for computing PMP is presented for both the general- and local-storm criteria. An example has been worked out for the general-storm criteria. (Author's abstract)
W89-06659

SNOW COVER AS AN INDICATOR OF CLIMATE CHANGE,
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 2C.
W89-06672

EXPERT SYSTEMS IN WEATHER FORECASTING AND OTHER METEOROLOGICAL APPLICATIONS,
Air Force Geophysics Lab., Hanscom AFB, MA.
For primary bibliographic entry see Field 7C.
W89-06674

EXPOSURE OF SMALL-SCALE AQUATIC SYSTEMS TO VARIOUS DEPOSITION LEVELS OF AMMONIUM, SULPHATE AND ACID RAIN,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 5C.
W89-06684

CHEMISTRY OF ATMOSPHERIC DEPOSITION AND LAKE ACIDIFICATION IN NORTHERN ITALY, WITH EMPHASIS ON THE ROLE OF AMMONIA,
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5C.
W89-06689

2C. Snow, Ice, and Frost

DAMAGE RESULTING FROM A SUDDEN RIVER ICE BREAKUP,
British Columbia Ministry of Environment, Kamloops. Water Management.
P. F. Doyle.
Canadian Journal of Civil Engineering, Vol. 15, No. 4, p 609-615, August 1988. 8 fig, 2 tab, 14 ref.

Descriptors: *Ice jams, *Ice breakup, *Damage, *Flood damage, *Ice run, Bridge failure, Bank erosion, Channel scour, Ice drift, Canada, Flooding.

On January 4, 1984, the Nicola River and its two main tributaries broke up suddenly due to a sharp increase in discharge from a rain-on-melting-snow event while the ice cover was still thick and strong. The resulting ice run and attendant jamming caused hundreds of thousands of dollars in damage to public and private property, including the killing of livestock, damage to trees, destruction of a bridge and several riprapped banks, destruction of fish eggs due to channel scour by ice blocks, and the movement of a mobile home 100 m downstream. Four ice jams remained in place for up to a week after the ice drive. All the damage was due either to the severe ice run within the channel or to flow forced out over the floodplain by ice jams. (Author's abstract)
W89-05827

CONFIGURATION AND PROPERTIES OF A BREAKUP JAM,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
S. Beltaos.
Canadian Journal of Civil Engineering, Vol. 15, No. 4, p 685-697, August 1988. 15 fig, 4 tab, 16 ref, 2 append.

Descriptors: *Ice jams, *Ice breakup, *Ice thickness, *Ice formation, Ice cover, Mathematical studies, Ice drift, Canada, Hydraulic friction, Ontario Rivers.

Favorable weather conditions in January, 1986, resulted in a breakup jam on the Thames River, Ontario, that froze in place. This afforded safe access and performance of detailed thickness measurements that are normally not possible to obtain. The thickness of the jam is highly variable in the lateral direction but without consistent trends, which, in a crude sense, justifies the assumption of lateral uniformity made for analytical purposes. In the downstream direction, the thickness increased, except for a short reach downstream of the toe where it rapidly decreased to zero. Approximate assessment of the absolute roughness of the jam indicated fair agreement with earlier deductions based on hydraulic resistance data. Using existing theoretical concepts, it was deduced that the downstream portion of the jam was likely formed by 'shoves' or internal collapse (wide channel jam) whereas the upstream portion was likely formed by frontal progression (narrow channel jam) and juxtaposition. For the former reach, the present data enabled approximate evaluation of coefficients utilized in pertinent theories. Agreement with previously published values was good, though in one instance there are no previous field determinations. To study the decline of jam thickness past the toe, the wide jam theory was adapted to describe a jam overlain by solid ice cover. This enabled approximate determination of the friction coefficient between the jam and the cover. (Author's abstract)
W89-05828

INFLUENCE OF ICE LAYERS ON THE TRAVEL TIME OF MELTWATER FLOW THROUGH A SNOWPACK,
Florida State Univ., Tallahassee. Dept. of Geology.
D. J. Furbish.
Arctic and Alpine Research ATLPAV, Vol. 20, No. 3, p 265-272, August 1988. 7 fig, 14 ref, append.

Descriptors: *Travel time, *Ice cover, *Snowmelt, *Snowpack, Mathematical models, Anisotropy, Darcys law, Saturated flow, Flow velocity.

The flow of water in the vicinity of ice layers within an isothermal snowpack is examined using Darcian laws. Treated as semipermeable boundaries, ice layers may reduce the residence time of water within the pack by delivering saturated flow to the downslope ice-layer edges, whence flow is transmitted downward faster than the speed of an unsaturated wave of meltwater that would exist in the absence of ice layers. This could produce a more rapid runoff than might be expected from a homogeneous snowpack. The effectiveness of this flow-timing mechanism depends on changing rates of meltwater influx. If a stratified snowpack is treated as an anisotropic medium, the anisotropy must be modeled as time-dependent over individual diurnal cycles. (Author's abstract)
W89-06196

EFFECTS OF GLACIAL ICE ON SUBSURFACE TEMPERATURES OF HYDROTHERMAL SYSTEMS IN YELLOWSTONE NATIONAL PARK, WYOMING: FLUID-INCLUSION EVIDENCE,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W89-06291

STUDIES OF A SUBARCTIC COASTAL MARSH: I. HYDROLOGY,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2L.
W89-06459

ROLE OF FRONTOGENETICAL FORCING AND CONDITIONAL SYMMETRIC INSTABILITY IN THE MIDWEST SNOWSTORM OF 30-31 JANUARY 1982,
Saint Louis Univ., MO. Dept. of Earth and Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W89-06538

SUPERCOOLED WARM RAIN PROCESS AND THE SPECIFICATION OF FREEZING PRECIPITATION,
Maryland Univ., College Park. Dept. of Meteorology.
G. J. Huffman, and G. A. Norman.
Monthly Weather Review MRWEAB, Vol. 116, No. 11, p 2172-2182, November 1988. 6 fig, 6 tab, 9 ref, 2 append. National Weather Service Cooperative Agreement NA85AA-H-SD124.

Descriptors: *Freezing, *Precipitation, *Supercooling, *Atmospheric physics, Ice, Melting, Atmospheric water, Regression analysis, Weather, Atmosphere, Clouds, Saturation, Temperature, Rainfall.

About 30% of freezing precipitation cases are observed to occur in a subfreezing atmosphere (contrary to the classical melting ice model). These cases are explained with the concept of the 'supercooled warm rain process' (SWRP); the warm rain process can yield liquid hydrometeors at subfreezing temperatures whenever too few ice nuclei are available to create solid hydrometeors. It was found that all of the freezing precipitation cases in a subfreezing atmosphere show a rapid decrease of moisture content in the zone above the inferred cloud top (decreasing from liquid to ice saturation in less than 20 mb), at temperatures ranging from 0 to -10 C. Additionally, this structure prevails among freezing cases (43%) much more than among solid or liquid cases (10% and 15%, respectively). Regression experiments demonstrated that freezing precipitation was best described when (discretized) predictors were combined to describe particular physical processes, such as the SWRP. Besides the SWRP, the usual melting ice process variables, such as cold-layer size, and surface temperature are important for specifying freezing precipitation. The system handles liquid and solid precipitation adequately, but is deficient in specifying freezing cases. This last result is in agreement with previous studies, and reflects the small sample size due to the rarity of freezing cases. (Author's abstract)
W89-06539

SNOW COVER AS AN INDICATOR OF CLIMATE CHANGE,
Lamont-Doherty Geological Observatory, Palisades, NY.
D. A. Robinson.
Available from National Technical Information Service, Springfield, VA 22161, as AD-A186 880. Price codes: A03 in paper copy, A01 in microfiche. 11p, 5 fig, 3 tab, 21 ref. NSF Grant ATM 86-18676 and Air Force Grant AFOSR 86-0053.

Descriptors: *Climate changes, *Climatology, *Data interpretation, *Snow cover, Projections, Air temperature, Weather data collections, Regional analysis, Satellite technology, Snow.

January snow cover in portions of the Midwest and Great Plains of the United States has shown significant variations during this century on year-to-year and long-term time frames. Over the past forty years, snow cover has increased in each region. This trend began in the late 1920's in the Plains, while in the Midwest the recent trend was preceded by several decade-long oscillations. Snow cover data used in the analysis included nearly complete records from twenty ground stations between 1901 and 1978 and weekly satellite-derived charts between 1967 and 1986. There is a reasonable agreement between regional analyses made with each of the independent data sets for the 1967-1978 interval. There appears to be a positive relationship between colder and snowier-than-normal and warmer-than-normal and relatively snow free Januaries. (Author's abstract)
W89-06672

EVALUATION OF THE MAGNETIC INDUCTION CONDUCTIVITY METHOD FOR DETECTING FRAZIL ICE DEPOSITS,
Cold Regions Research and Engineering Lab., Hanover, NH.
For primary bibliographic entry see Field 7B.
W89-06673

CHLOROPHENOL COMPOUNDS IN SNOW,
Jyvaeskylae Univ. (Finland). Inst. for Environment Research.
For primary bibliographic entry see Field 5A.
W89-06761

ICE AND SEDIMENT FACTORS IN THE SELECTION OF INUIT WATER SUPPLIES FROM LENTIC SOURCES,
Wisconsin Univ.-Milwaukee. Dept. of Geography.
For primary bibliographic entry see Field 5F.
W89-06935

2D. Evaporation and Transpiration

PARAMETERIZATION OF REGIONAL EVAPORATION: SOME DIRECTIONS AND STRATEGIES,
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
W. Brutsaert.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 409-426, September 30, 1988. 6 fig, 59 ref. NSF Grant ATM-8601115.

Descriptors: *Model studies, *Evaporation, *Regional analysis, *Runoff, *Hydrologic models, *Water loss, Climatology, Turbulent transport, Boundary processes, Latent heat, Sensible heat, Parameterization, Research priorities, Mathematical models.

The success of currently available methods for predicting runoff and other facets of watershed hydrology depends on a knowledge of the water 'losses' through evaporation. General circulation models of climate dynamics appear to be quite sensitive to the statement of land surface processes in general, and of evaporation in particular. Several approaches dealing with this problem have resulted from advances in the description of turbulent transport phenomena in the atmospheric boundary layer. Issues under investigation are the dissimilarity between sensible and latent heat transport, the simple slab concept for budget calculations and the development of bulk transfer equations. A number of large-scale experiments, some just completed, will improve present understanding and parameterization techniques for surface fluxes of water vapor and related land surface

processes. Recent developments of concepts and some experimental activities are reviewed, including: flux-profile relationships (similarity and dissimilarity), boundary layer budgets with slab approach, bulk transfer methods, and mesoscale experimentation. (Author's abstract)
W89-05861

EVAPORATION FROM LAKE BIWA,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
S. Ikebuchi, M. Seki, and A. Ohtoh.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 427-449, September 30, 1988. 14 fig, 7 tab, 8 ref.

Descriptors: *Instrumentation, *Data acquisition, *Lake Biwa, *Evaporation, Estimating, Evaporation pans, Eddy correlation method, Heat balance, Aerodynamic method, Bulk transfer, Water temperature, Wind velocity, Air temperature, Humidity, Seasonal distribution, Annual variation, Comparison studies.

An experiment has been under way since 1985 to determine the best method to estimate the evaporation from Lake Biwa (Japan). A comparison of direct measurements by the eddy correlation method and large evaporation pan method, and the indirect estimation by the aerodynamic and heat balance method was made. As a result, the estimation of evaporation from Lake Biwa was carried out for a long continuous time by the bulk transfer method, based on measurements of surface water temperature, wind velocity, air temperature, and humidity at about 6 m above the lake surface, made on a platform 200 m offshore. The annual variation of evaporation was greater in autumn and winter (September to March) than in spring and summer (April to August). (Author's abstract)
W89-05862

WEIGHING LYSIMETER IN A REGENERATING EUCALYPT FOREST: DESIGN, CONSTRUCTION, AND PERFORMANCE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
For primary bibliographic entry see Field 7B.
W89-05886

INTERCEPTION LOSS FROM EUCALYPT FOREST: LYSIMETER DETERMINATION OF HOURLY RATES FOR LONG TERM EVALUATION,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
F. X. Dunin, E. M. O'Loughlin, and W. Reyenga.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 315-329, October-December 1988. 7 fig, 2 tab, 31 ref.

Descriptors: *Lysimeters, *Forest hydrology, *Interception loss, *Canopy, *Eucalyptus forests, Coniferous forests, Australia, New Zealand, Rainfall.

Analyses of the response by a weighing lysimeter in Kioloa State Forest during and after rainfall provided values of interception loss rate. The derived rates for time scales between 0.1 and 1.0 mm/h were generally similar throughout storm events to losses determined from throughfall and stemflow observations. During post-rainfall periods of canopy drying, enhanced rates of lysimeter evaporation were consistent with micrometeorological determinations of the partitioning of available radiant energy, based on atmospheric gradients of humidity and temperature. Interception losses from the eucalypt forest, deduced from the lysimeter response, varied between 10 and 15 percent of gross rainfall in 3 consecutive 12 month periods whereas the corresponding rainfall ranged between 590 and 1530 mm/yr. Daytime losses accounted for about 2/3 of total interception loss with a similar fraction occurring during rain periods. Storage capacity of the evergreen forest canopy was inferred to 0.35 mm. Hourly loss rates during rainfall ranged up to 0.8 mm/h but with decreasing mean values and variability with increasing time scale resulting in a monthly mean value computed for the total number of hours of rain of approximately 0.1 mm/h. A preliminary analysis of loss rate in terms of storm windspeed and rainfall intensity explained about half of its variation in statistically derived relationships. Improved time resolution of the order of seconds was considered a prerequisite to the physical understanding of turbulent transport from saturated canopies. The small value of interception storage capacity was considered in relation to that for pine forest as a basis for explaining observed differences in interception behavior between eucalypt forest and coniferous plantations in the same area. Large differences in interception losses between the Kioloa site and evergreen forest in the South Island of New Zealand and also eucalypt forest in Western Australia were attributed to dissimilar meteorological conditions at the various sites. (See also W89-05886) (Author's abstract)
W89-05887

PARAMETERIZATION OF THE EVAPORATION OF RAINFALL,
Oregon State Univ., Corvallis. Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W89-05908

IMPROVING PROJECTED POTENTIAL EVAPOTRANSPIRATION ESTIMATES USING NATIONAL WEATHER SERVICE FORECASTS,
Nebraska Univ.-Lincoln. Center for Agricultural Meteorology and Climatology.
S. J. Meyer, K. G. Hubbard, and D. A. Wilhite.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 10, p 1183-1188, October 1988. 1 fig, 4 tab, 9 ref. National Climate Program Office Grant 87-123-032-01.

Descriptors: *Evapotranspiration potential, *Weather, Climatology, Meteorology, Estimating, Projections, Climatic data, Air temperature, Estimating equations, Relative humidity, Solar radiation.

The results of a survey conducted by the University of Nebraska's Center for Agricultural Meteorology and Climatology of Agricultural Network users are discussed. The results of potential evapotranspiration projections (calculated using the Blaney-Criddle approach, which employs normal climatic data to project potential evapotranspiration estimates up to three days into the future) were labeled unrealistic. To improve these projections, National Weather Service forecast variables were used as input into the Blaney-Criddle and Penman equations. Potential evapotranspiration projections calculated according to the Penman equation, with data measured by automated weather stations as input, were assumed to represent the best projections for the summer of 1985. Increased accuracy in potential evapotranspiration projections due to increased accuracy in the individual forecasted input variables was evaluated. Overall, daily potential evapotranspiration projections made with the Blaney-Criddle equation were substantially improved using the National Weather Service forecasted temperature in place of normal temperature; over a growing season, however, accurate estimates resulted from using normal temperatures. The use of National Weather Service-forecasted variables as input into the Penman equation offers the greatest potential for improving potential evapotranspiration projections. 'Overforecasting' of all variables limited the ability of the Penman equation in this study. For greatest improvement in potential evapotranspiration projections using the Penman equation, efforts should be concentrated on improving forecasts of relative humidity and solar radiation. (Author's abstract)
W89-06002

CHEMICAL AND MINERALOGICAL EFFECTS OF SALINE WATER MOVEMENT THROUGH A SOIL DURING EVAPORATION,
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
For primary bibliographic entry see Field 2G.
W89-06011

ADDITIONAL SOLUTIONS FOR STEADY-STATE EVAPORATION FROM A SHALLOW WATER TABLE,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
A. W. Warrick.
Soil Science SOSCAK, Vol. 146, No. 2, p 63-66, August 1988. 1 tab, 6 ref.

Descriptors: *Mathematical analysis, *Water table, *Evaporation, Mathematical models, Soil water, Water table fluctuations, Numerical analysis, Capillary conductivity.

Evaporation from a shallow water table is examined to provide addition analytical solutions for steady-state evaporation. An unsaturated conductivity function K of the form K = a/(S(to the nth power) + b) is used, where S is the matric suction, and a, b, and n are constants. The results of Gardner and Fireman (1958) are generalized to all n > 1, including fractional values, and b = 0, for which K reduces to the form commonly referred to as that of Brooks and Corey. A table is presented from which evaporation rates follow for a wide range of depths and hydraulic conductivity functions of the above form. These figures may be used either for direct calculations of evaporation or for checking numerical algorithms. (Geiger-PTT)
W89-06481

INTERMITTENT EVAPORATION, MOISTURE DISTRIBUTION, AND SALT REDISTRIBUTION THROUGH SALINE-SODIC CLAY SOIL AS AFFECTED BY IRRIGATION FREQUENCY AND QUANTITY,
Khartoum Univ. (Sudan). Dept. of Agricultural Engineering and Soil Science.
M. H. Dahab, M. A. Mustafa, and H. A. Abdel Rahman.
Soil Science SOSCAK, Vol. 146, No. 3, p 168-175, September 1988. 8 fig, 5 tab, 17 ref.

Descriptors: *Saline soils, *Evaporation, *Clays, *Irrigation effects, *Salt, *Soil water, Leaching, Adsorption, Soil profiles, Conductivity, Soil texture, Soil moisture retention, Mathematical analysis.

The effects of three intervals (5, 10, and 20 days) and four total amounts of irrigation water (120, 240, 360, and 480 mm) applied at two rates (3 or 6 mm/day) on intermittent evaporation, soil moisture distribution, and salt redistribution through saline-sodic clay soil columns with initial zonal distribution of salts was investigated. The results indicated that after a threshold period, which was longer for the lower rate of water application, cumulative evaporation (E) increased with decrease in irrigation interval. In accordance with previous findings, E was a linear function of the square root of time, i.e., E = c(the square root of t), where c, under the experimental conditions, is largely determined by the amount of water applied per irrigation. The transmission zone of the moisture distribution profiles lengthened and the wetting front advanced deeper, and consequently salt leaching improved as time progressed and as the irrigation interval and the amount of water applied increased. The sodium adsorption ratio profiles qualitatively followed the electrical conductivity, EC(subscript 1:5), redistribution patterns. The depth of the wetting front and the amount of the water stored accounted for 97.4 and 96.8% (r (subscript .001) = 0.872) of the variability of the depth of the desalinized zone, respectively. The amount of the stored water accounted for 68% (r(subscript 0.1) = 0.765) of the variability of the weighted mean EC(subscript 1:5) of the desalinized zone. (Author's abstract)
W89-06484

GCM SIMULATION STUDY OF THE INFLUENCE OF SAHARAN EVAPOTRANSPIRATION AND SURFACE-ALBEDO ANOMALIES ON JULY CIRCULATION AND RAINFALL,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W89-06542

EVAPORATION AND WEATHER: TECHNICAL MEETING 44, EDE, THE NETHERLANDS, 25 MARCH 1987.
The Hague, Netherlands. Proceedings and Information/TNO Committee on Hydrological Research; no. 39. 1987. 98p. Edited by J.C. Hooghart.

Descriptors: *Evaporation, *Weather, *Symposium, *The Netherlands, Meteorological data collection, Agriculture, Hydrology, Macrohydrology, Radiation, Air temperature, Weather forecasting, Estimating, Model studies, Air circulation, Climatology.

The papers in this technical meeting on evaporation and weather volume start with meteorology's traditional role in supplying evaporation data for use in agriculture, hydrology, etc. A new practice adopted for computing evaporation data for the Netherlands on a daily basis is described. The new method is based on a simple formula for estimating evaporation from observed data on global radiation and air temperature only. It replaces the method based on the well-known Penman formula. It seems logical that evaporation data eventually will be produced as a byproduct of limited-area numerical weather-prediction models. Present operational models are still incapable of adequately resolving the small-scale differences in evaporation. However, the basic principles of such models are discussed. Papers on the physical aspects and on a specific model indicate the potential capability of weather models in the estimation of evaporation. The more far-reaching developments related to hydrology in general in large-scale global circulation models (GCMs) are also discussed. The term 'macrohydrology', defining those activities which seek to improve the incorporation of hydrological processes, including evaporation, into GCMs, is introduced. The meeting which generated these proceedings will doubtless need to be followed a few years from now by one covering the subject from a climate-modeling viewpoint. (See W89-06699 thru W89-06704) (Shidler-PTT)
W89-06698

METEOROLOGICAL USE OF EVAPORATION DATA,
Royal Netherlands Meteorological Inst., De Bilt.
C. J. E. Schuurmans.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 1-3. 2 ref.

Descriptors: *Meteorological data collection, *Evaporation, Air masses, Water vapor, Weather forecasting, Weather patterns, Hydrologic cycle, Simulation, Agriculture, Forestry, Climatology.

Air-mass properties determining weather are strongly dependent on the input of water vapor from the earth's surface. So for weather-prediction purposes evaporation data, or methods to compute evaporation, are needed. Evaporation as a component of the global hydrological cycle plays an extremely vital role in numerical simulation of world climate. Data on evaporation to be used in agriculture, hydrology, forestry, etc., are usually supplied by meteorologists. Recent developments have made evaporation of major interest for use by physical climatologists and meteorologists themselves. Improvements are needed in our understanding of the relation between small-scale hydrological processes and average descriptions for large areas, used in global circulation models. On the one hand there is the user of evaporation data on scales of tens of kilometers or less, while on the other evaporation-process descriptions are needed as inputs for large-scale global climate models on scales of the order of 300 x 300 km. These descriptions are already used in some operational weather-prediction models (e.g., in the model of the European Center for Medium Range Weather Forecasts on which the Netherlands' 5-day forecasts are based). The emergence of global-scale hydrology brings evaporation and other hydrological processes to the forefront of both research and application. (See also W89-06698) (Shidler-PTT)
W89-06699

FROM PENMAN TO MAKKINK,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
H. A. R. de Bruin.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 5-31. 1 fig, 4 tab, 34 ref.

Descriptors: *Evapotranspiration potential, *Mathematical equations, *Estimating equations, Penmans equation, Makkinks expression, Open-water evaporation, Reference-crop evapotranspiration, Crop factor, Evaporation, Estimating, Comparison studies, Correlation analysis, Meteorological data collection, The Netherlands.

The background and applicability of Penman's equation is briefly discussed. Commonly, the so-called 'open water evaporation' (OWE), which is obtained with the Penman formula, is multiplied by a suitable crop factor to obtain an estimate of the 'potential' evapotranspiration. This 'crop factor method' appears to be rather crude. OWE--despite its name--cannot be used for 'real' open water. Another important drawback is the fact that there is a lot of confusion about the way it is calculated. This confusion is the main reason that the Royal Netherlands Meteorological Institute has decided to stop the routine publication of OWE. Since there was still a need for an evaporation estimate similar to OWE which could be used in the crop-factor approach, an alternative for OWE was sought. The formula proposed by Makkink appeared to be very suitable for this purpose. A new evaporation estimate based on Makkink's expression is called the 'reference crop evapotranspiration' (RCE). The background of the RCE is discussed. In addition, a comparison is presented between the RCE and the 'old' quantity OWE. This comparison reveals that in the growing season (April through September) the two quantities are correlated very well. Finally, it is noted that crop factors, which allow the use of the crop factor method, have been derived using the RCE as reference. (See also W89-06698) (Shidler-PTT)
W89-06700

CROP FACTORS IN RELATION TO MAKKINK REFERENCE: CROP EVAPOTRANSPIRATION,
Institute for Land and Water Management Research, Wageningen (Netherlands).
R. A. Feddes.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 33-45. 3 tab, 2 fig, 21 ref.

Descriptors: *Evapotranspiration, *Mathematical equations, *Reference-crop evapotranspiration, *Crop factor, Penmans equation, Open-water evaporation, Makkinks expression, Advection, Irrigation practices, Climatology, Soil water, Radiation, Air temperature.

In order to compute maximum possible evapotranspiration of a certain crop, EMAX, this quantity is often related empirically to the evaporation of a hypothetical shallow-water surface, called 'open-water evaporation', OWE. EMAX is related to OWE simply by multiplying OWE by a 'crop factor', g. Note that g-values were derived from fields with different local conditions and agricultural practices. These local effects may include size of fields, advection, irrigation and cultivation practices, climatological variations in time and altitude, and soil-water availability. Instead of taking the evaporation of a hypothetical water surface as a reference to calculate EMAX, the evapotranspiration of a reference crop, i.e., of 'standard' grass 8 to 13 cm high, well supplied with water, can be used. EMAX can thus be computed as the product of a new crop factor, f, and the 'reference-crop evapotranspiration' (RCE), the maximum possible evapotranspiration of grass according to Makkink. The Makkink relationship has the advantage over OWE that easily-measurable quantities such as global radiation and air temperature will sufficiently describe evapotranspiration. The new crop factors f can be derived from the old factors g. All the remarks that were made concerning the g-factors are also valid for the f-factors, so one has always to be careful in applying these data. (See also W89-06698) (Shidler-PTT)
W89-06701

CLIMATOLOGICAL DATA ON EVAPORATION IN THE NETHERLANDS: PAST, PRESENT AND FUTURE,
Royal Netherlands Meteorological Inst., De Bilt.
W. N. Lablans.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 47-62. 3 fig, 1 tab, 13 ref.

Descriptors: *Evaporation, *Climatology, *Data collections, *The Netherlands, Institutions, Organizations, Publications, Penmans equation, Makkinks expression, Reference-crop evapotranspiration, Radiation, Temperature, Networks.

The various time series of evaporation published by the Royal Netherlands Meteorological Institute (KNMI) are discussed and the future practice of the calculation and the dissemination of evaporation data by KNMI is described. Data on evaporation for a number of stations have been published by the KNMI since 1911. Until March 1987, the evaporation data were calculated according to Penman's method. As various modifications of the original method have been introduced, both inside and outside KNMI, confusion has arisen about the precise significance of the various data sets published in the KNMI climatological bulletins and in monographs. Therefore a Working Group, with representatives of KNMI and the Netherlands Organization for Applied Scientific Research Committee on Hydrological Research as members, advised that KNMI should stop using the Penman method and in the future should adopt a method proposed by G. F. Makkink. Accordingly it has been decided to calculate, beginning April 1st 1987, a reference-crop evapotranspiration (RCE). Values for RCE will be calculated from daily values of global radiation and temperature for a network of stations. Data on RCE, both for decades and monthly, will be published in the Monthly Climatological Bulletins of KNMI. Besides this, data (also daily values) can be obtained on request on shorter notice. (See also W89-06698) (Author's abstract)
W89-06702

EVAPORATION AND WEATHER: INTERACTIONS WITH THE PLANETARY BOUNDARY LAYER,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
H. A. R. de Bruin, and A. A. M. Holtslag.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 63-83. 6 fig, 24 ref.

Descriptors: *Evaporation, *Weather, *Air-earth interfaces, Boundary layers, Water vapor, Temperature, Humidity, Mathematical equations, Turbulence, Heat flow, Estimating, Weather forecasting, Model studies, Soil temperature, Latent heat.

The main source for atmospheric water vapor is evaporation at the earth's surface. The interrelations between evaporation on one hand and the temperature and humidity of the planetary boundary layer (PBL) on the other are illustrated, using simple examples. From these examples it is made clear why the evaporation formulas of Priestley and Taylor and of Makkink work so well. The turbulent state of the PBL appears to be primarily determined by the wind speed, surface roughness, and the surface fluxes of sensible heat (H) and water vapor (E). Evaporation, E, plays an important role in this story. Normally, it appears that a Priestley/Taylor type of estimate can be used for the surface fluxes E and H. In a weather-prediction model for the PBL, initial conditions are needed for temperature and humidity together with the surface fluxes of H and E. It is characteristic that the surface fluxes need to be described in terms of other predictable quantities to solve the PBL equations. During daytime the surface fluxes H and E are defined with the Priestly/Taylor approach, soil

heat flux is related to net radiation (Q*), and Q* is defined in terms of predicted total cloud cover and solar elevation. During nighttime the latent-heat flux is generally small, and the sensible-heat flux is strongly influenced by wind speed. (See also W89-06698) (Shidler-PTT)
W89-06703

INTERNATIONAL INVESTIGATIONS OF LARGE-SCALE EVAPORATION,
Institute of Hydrology, Wallingford (England).
W. J. Shuttleworth.
IN: Evaporation and Weather: Technical Meeting 44, Ede, The Netherlands, 25 March 1987. The Hague, Netherlands. 1987. p 85-98. 2 fig, 13 ref, append.

Descriptors: *Evaporation, *Model studies, *Macrohydrology, Computers, Hydrologic data, Calibration, Tropical regions, Forests, Agricultural watersheds, Aircraft, Satellite technology.

An important, growing, and internationally-recognized area of hydrological interest has come to be called 'Macrohydrology'; its most important and novel aspect is that limited resources, both in the computers used to model climate and in the experimental and observational data used to calibrate them, necessitate the creation of average process descriptions relevant to large areas. Three recent or ongoing international experiments designed to improve our knowledge of surface processes, and their description at a scale and complexity consistent with that required in such atmospheric models are described: (1) The results of a two-year, single-site study in central Amazonia provide calibration of tropical forest vegetation in new land-surface descriptions specifically designed for use in climate models. (2) The Hydrologic Atmospheric Pilot Experiment, carried out in southwest France, provided detailed measurements of weather and surface-flux variables simultaneously over several agricultural and forest crops, and will investigate their integration to larger scale using aircraft, satellite, and catchment data. (3) The First International Satellite Land Surface Climatology Program Field Experiment, taking place during 1987/8 in Kansas, will investigate and evaluate the potential use of satellite data for routine climate monitoring, and climate model calibration. (See also W89-06698) (Author's abstract)
W89-06704

2E. Streamflow and Runoff

NOVEL METHOD FOR STUDYING PLASMID TRANSFER IN UNDISTURBED RIVER EPILITHON,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W89-05794

DESIGN AND USE OF A HYDRAULIC POTENTIOMANOMETER FOR DIRECT MEASUREMENT OF DIFFERENCES IN HYDRAULIC HEAD BETWEEN GROUNDWATER AND SURFACE WATER,
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 7B.
W89-05808

GRID-BASED APPLICATION OF RUNOFF CURVE NUMBER,
Pennsylvania State Univ., University Park. Dept. of Geography.
D. White.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 601-612, November 1988. 6 fig, 3 tab, 15 ref, append. DOE Grant DE-FG02-84ER60262.

Descriptors: *Runoff forecasting, *Rainfall-runoff relationships, *Rainfall distribution, Spatial distribution, Infiltration, Vegetation, Land use, Storm runoff, Prediction, Mathematical models, Small watersheds, Hydrologic models, Pennsylvania.

The development and validation of a methodological approach to predicting runoff over large regions is considered. The Soil Conservation Service (SCS) runoff curve number procedure is modified to allow for areal variation of land use and land cover, soils, and rainfall over a regular-gridded network. Ten rainfall events, from the period 1973-1980, are selected to estimate runoff for the Mahantango Creek Watershed (421 sq km) in east-central Pennsylvania. The method may be useful in generating a geographic information system database for distributed-components hydrologic models and for water resources management. (Author's abstract)
W89-05816

FLOOD DEPTH-DAMAGE CURVES BY INTERVIEW SURVEY,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
E. A. McBean, J. Gorrie, M. Fortin, J. Ding, and R. Moulton.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 613-634, November 1988. 2 fig, 3 tab, 14 ref, 2 append.

Descriptors: *Statistical analysis, *Flood data, *Flood damage, *Surveys, Flood plain management, Property value, Flooding, Quantitative analysis, Cost analysis.

Results of interview surveys for potential flood damages are used to develop depth-damage curves for structural and content groupings and alternative residence types. Statistical significance tests are used to collapse 28 structural categories into seven basic groups. The exterior of the residence is demonstrated to not necessarily be a good indicator of the potential flood damage to the contents. Use of average curves are recommended except in the very obvious circumstances of very low and/or very high valued residences. Results of the analyses indicated that the relative proportion of structural damages to contents damages is approximately unity at 2.4 m depth. The proportion of contents damages was generally higher for residences with basements than those without. Flood damages for individual structures are highly variable within structural categories, across structural categories, and across communities. Readily apparent differences in the exterior character of structures were not closely correlated with estimates of potential flood damages. It is very difficult, under field conditions, to classify residences by flood damage potential (low, average, high) in a reliable manner. (See also W89-05818) (Author's abstract)
W89-05817

ADJUSTMENT FACTORS FOR FLOOD DAMAGE CURVES,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
E. A. McBean, J. Gorrie, M. Fortin, J. Ding, and R. Moulton.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 635-646, November 1988. 7 tab, 13 ref.

Descriptors: *Statistical analysis, *Flood data, *Flood damage, *Flood protection, Mathematical studies, Flow velocity, Regression analysis, Cost analysis, Prediction, Flood forecasting, Property value, Estimating, Ice, Flow velocity.

Estimates are provided for quantifying adjustments to depth-damage tables as a result of flooding events of different types on residential dwellings. The adjustments reflect estimated changes to flood damages due to the availability of flood warning, long durations of flooding, and ice and high velocity flow. Regression analyses are described that examine the degree to which a range of variables, including a resident's experience with flooding, householder income, floor area of residence, and assessed value of property, can explain the variability of flood damage curves. For longer duration floods (taken as greater than 24 hr) the total damages should be increased by 6%. For total destruction due to ice, or high-velocity flows, the loss of contents were valued at 66% of the total damages at 2.4 m. Total destruction also includes loss of the structure valued at the property value minus the value of the land or lot. (See also W89-05817) (Author's abstract)
W89-05818

OPERATIONAL GUIDANCE DURING DROUGHTS: EXPERT SYSTEM APPROACH,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-05819

ROLE OF BOTTOM MORPHOLOGY ON ESTIMATION OF THE TRANSPORT OF SOLIDS IN RIVERS (LE ROLE DE LA CONFORMATION DU FOND DANS L'ESTIMATION DU TRANSPORT SOLIDE EN RIVIERE),
Ecole Hassania des Travaux Publics, Casablanca (Morocco).
For primary bibliographic entry see Field 2J.
W89-05823

ROUGHNESS OF REVERSE FLOW OVER DUNES AND ITS APPLICATION TO THE MODELLING OF THE PITT RIVER,
National Water Research Inst., Burlington (Ontario). Environmental Hydraulics Section.
Y. L. Lau.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 547-552, August 1988. 6 fig, 3 tab, 9 ref.

Descriptors: *Tidal waves, *Discharge measurement, *Tidal streams, *Roughness coefficient, *Flow friction, River beds, Dunes, Simulation analysis, Channel morphology, Hydraulic roughness, Model studies, British Columbia, Calibrations, Flow Discharge, Tidal currents, Flow resistance, Model testing.

A stretch of approximately 43 km on the Fraser River, British Columbia, and about 22 km on the Pitt River, which is a tributary of the Fraser, was modeled. Because of tidal action on the Fraser, the flow in the Pitt River reverses in direction between flood and ebb stages. During the calibration of the model, in which Manning's roughness coefficient was adjusted until the simulated values of discharge and water-surface elevation agreed with measured data, it was discovered that the discharge for the Pitt River section could not be simulated by using a constant value for Manning's coefficient. A smaller value had to be used to simulate the ebb flow. Experiments using artificial dunes show that the friction factor is reduced when the steepface of the dune is on the upstream side, i.e., when the direction is reverse that of normal. Calculations using bedform regime relationships show that this configuration of reverse flow over dune profiles could have existed in the Pitt river, causing the decrease in bed roughness which was found during the calibration runs. During the ebb flow period, the flow is likely going in the reverse direction over the dunes which were formed during the flood flow period. The flow resistance is controlled by the dune bed profile, even though the flow conditions during most of the tidal cycle are in the range where only ripples would exist if the flow were unidirectional and steady. The manner in which the flow changes has a very important effect. If the flow decreases very rapidly, the dunes which were formed may remain intact and the dunes may exist in a flow that is not even strong enough to initiate sediment movement. If the same flow decreases very gradually, the dunes may be altered significantly. (Geiger-PTT)
W89-05825

DAMAGE RESULTING FROM A SUDDEN RIVER ICE BREAKUP,
British Columbia Ministry of Environment, Kamloops. Water Management.
For primary bibliographic entry see Field 2C.
W89-05827

SOME ALTERNATIVE APPROACHES TO MATHEMATICAL MODELLING OF RESERVOIR SYSTEMS,
Durban-Westville Univ. (South Africa).
For primary bibliographic entry see Field 4A.
W89-05836

ASSESSMENT OF THE WATER SURFACE PROFILE MODEL: ACCURACY OF PREDICTED INSTREAM FISH HABITAT CONDITIONS IN LOW-GRADIENT, WARMWATER STREAMS,
Illinois Natural History Survey, Champaign.
For primary bibliographic entry see Field 2H.
W89-05840

RUNOFF GENERATION AND HYDROLOGIC RESPONSE VIA CHANNEL NETWORK GEOMORPHOLOGY: RECENT PROGRESS AND OPEN PROBLEMS,
Mississippi Univ., University. Dept. of Civil Engineering.
V. K. Gupta, and O. J. Mesa.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 3-28, September 30, 1988. 5 fig, 3 tab, 50 ref. Army Research Office Grant 21078-GS.

Descriptors: *Rainfall-runoff relationships, *Runoff, *Geomorphology, *Drainage patterns, *Channel networks, Theoretical analysis, Stochastic hydrology, Mathematical models, Runoff forecasting, Climate, Hydrology.

Recent theoretical emphasis on quantifying the processes of runoff generation in space-time in river basins has given a new focus to the fundamental importance of channel network geomorphology in river basin hydrology. Of particular significance in this context is the need for a comprehensive quantitative theory of channel networks in three dimensions reflecting the constraints of space filling and available potential energy as well as climatic, hydrologic, and geologic controls which are in dynamic equilibrium with channel network forms. Recent progress related to these issues is discussed in a nontechnical way and illustrated with examples, and important open problems are discussed. Random model postulates, stochastic analysis of the width function, channel networks and hydrologic response, and channel networks and runoff generation (including random model predictions of the width function and random model predictions of the link concentration function) are covered. (Rochester-PTT)
W89-05841

EFFECTS OF SPATIAL VARIABILITY AND SCALE WITH IMPLICATIONS TO HYDROLOGIC MODELING,
Princeton Univ., NJ. Water Resources Program.
E. F. Wood, M. Sivapalan, K. Beven, and L. Band.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 29-47, September 30, 1988. 6 fig, 17 ref, 3 append. NASA Grant NAG 5-491 and USGS Grant 14-08-0001-G1138.

Descriptors: *Catchment areas, *Runoff volume, *Hydrologic models, *Representative Elementary Area, *Model studies, *Mathematical models, *Rainfall-runoff relationships, Coweeta River, North Carolina, Rainfall, Soils, Topography, Variability, TOPMODEL, Mathematical models.

The results are reported of a preliminary investigation into the existence of a Representative Elementary Area (REA) in the context of hydrologic modeling on the catchment scale. The investigation was carried out for an actual catchment topography at the Coweeta River experimental basin (North Carolina) with synthetic realizations for rainfall and soils. The hydrologic response of this catchment was modeled by a modified version of TOPMODEL, which is capable of modeling both infiltration excess and saturation excess runoff and incorporating the spatial variability of soils, topography, and rainfall. The effect of scale was analyzed by first dividing the catchment into smaller subcatchments and determining the average water fluxes for each subcatchment. The preliminary results lead to the following conclusions: (1) a REA exists in the context of catchment hydrologic responses; (2) the REA is strongly influenced by the topography; and (3) based on initial results, the length scale of rainfall seems to have only a secondary role in determining the size of the REA, but increases in the variability of rainfall and soils between subcatchments increase the variability of runoff generation between subcatchments. (Author's abstract)
W89-05842

TECHNOLOGICAL DEVELOPMENTS IN REAL-TIME OPERATIONAL HYDROLOGIC FORECASTING IN THE UNITED STATES,
National Weather Service, Silver Spring, MD. Office of Hydrology.
M. D. Hudlow.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 69-92, September 30, 1988. 13 fig, 2 tab, 55 ref.

Descriptors: *Hydrology, *United States, *Forecasting, *Model studies, *Computer models, *Weather forecasting, *Streamflow forecasting, *Flood forecasting, National Weather Service, Technology, Data acquisition, Prediction, Seasonal variation.

The hydrologic forecasting service of the United States spans applications and scales ranging from those associated with the issuance of flood and flash warnings to those pertaining to seasonal water supply forecasts. New technological developments (underway or planned by the National Weather Service (NWS) in support of the Hydrologic Program) are carried out as combined efforts by NWS headquarters and field personnel in cooperation with other organizations. These developments fall into two categories: (1) hardware and software systems technology and (2) hydrometeorological analysis and prediction technology. Cornerstones of an overall NWS modernization effort include implementation of state-of-the-art data acquisition systems (including the Next Generation Radar) and communications and computer processing systems. The NWS Hydrologic Service will capitalize on these systems and will incorporate results from specific hydrologic projects, including collection and processing of multivariate data sets, conceptual hydrologic modeling systems, integrated hydrologic modeling systems with meteorological interfaces and automatic updating of model states, and extended streamflow prediction techniques. Salient aspects of ongoing work in these areas are discussed here to provide some perspective on the future hydrologic forecasting service in the United States and on its transitional period in the 1990s. (Author's abstract)
W89-05844

HACHIOJI EXPERIMENTAL BASIN STUDY: STORM RUNOFF PROCESSES AND THE MECHANISM OF ITS GENERATION,
Tsukuba Univ. (Japan). Inst. of Geoscience.
T. Tanaka, M. Yasuhara, H. Sakai, and A. Marui.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 139-164, September 30, 1988. 19 fig, 4 tab, 35 ref. Ministry of Education, Science and Culture (Japan) Grants-in-Aid 546205, 57025009, and 58020010.

Descriptors: *Rainfall-runoff relationships, *Groundwater movement, *Runoff, *Storm runoff, *Surface-groundwater relations, Catchment areas, Pipe flow, Flow discharge, Forests, Japan, Slopes, Storms.

Storm runoff processes and the mechanism of its generation in relation to dynamic responses of subsurface water in a small forested drainage basin located in the western suburbs of Tokyo, Japan, are discussed. Intensive field observations were carried out for the period 1980-1983. In the drainage basin overland flow occurred from restricted areas on the valley floor. No significant overland flow was produced on the steep hillside slopes even during a heavy storm event. The maximum extent of the saturated area occupied only 1-4% of the total basin area. The main source of storm runoff was groundwater flow. More than 90% of the total discharge was due to groundwater flow and the surface flow component contributed less than 10%. The rapid and large amounts of groundwater discharge during a storm event could not be explained solely by the traditional concept of Darcian matrix flow. These phenomena were attributed mainly to rapid flow such as pipe flow, which has velocities about as high as those of surface flows. The pulsating flow phenomenon was observed as a characteristic of pipe flow. (Author's abstract)
W89-05847

RUNOFF PROCESS ON A STEEP FORESTED SLOPE,
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Forestry.
Y. Tsukamoto, and T. Ohta.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 165-178, September 30, 1988. 10 fig, 3 tab, 6 ref.

Descriptors: *Rainfall-runoff relationships, *Runoff, *Storm runoff, *Slopes, *Surface-groundwater relations, Topography, Catchment areas, Pipe flow, Flow discharge, Overland flow, Weathering, Soil water, Throughflow, Clays, Gravel, Forests, Japan, Storms.

A study was conducted to clarify the storm runoff process on an entire hillslope by synthesizing the results measured on individual slope segments. Three slope units were defined by combining nine basic slope types. A convergent slope unit is called a zero-order basin, because it combines a slope and a stream. Field measurements were obtained of the runoff process of stormflow on experimental slopes composed of clayey gravel and clay of Pliocene age. Pipe flow and saturated overland flow play an important part on convergent colluvial slope units. Surface soils significantly influence saturated throughflow on creeping middle slopes. The depth of weathering has a major effect on initial moisture storage for residual creeping slopes. A subsurface storm flow pattern on a typical Pliocene slope is reconstructed based on field measurements. (Rochester-PTT)
W89-05848

STREAMWATER CHEMISTRY DURING RAINFALL EVENTS IN A FORESTED BASIN,
National Inst. for Environmental Studies, Yatabe (Japan). Div. of Water and Soil Environment.
For primary bibliographic entry see Field 2J.
W89-05852

EFFECT OF INITIAL SOIL MOISTURE CONTENT ON THE VERTICAL INFILTRATION PROCESS: A GUIDE TO THE PROBLEM OF RUNOFF-RATIO AND LOSS,
Tokyo Inst. of Tech. (Japan). Dept. of Civil Engineering.
M. Hino, Y. Okada, K. Nadaoka, and A. Sato.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 267-284, September 30, 1988. 21 fig, 1 tab, 23 ref.

Descriptors: *Infiltration, *Soil water suction, *Soil water, *Rainfall-runoff relationships, *Hydraulic models, Mathematical models, Analog models, Tensiometers, Lysimeters, Artificial precipitation, Rainfall intensity, Wetting, Wave propagation, Numerical analysis, Mathematical equations.

The relationships among the initial soil suction (an index of soil moisture content), total amount of rainfall, rainfall intensity, runoff loss, runoff ratio, and lag between rainfall and runoff occurrence were examined with a simplified one-dimensional analog model of the infiltration process based on a cylindrical lysimeter with artificial rainfall. It is shown conclusively that the loss of infiltrated rainfall is correlated uniquely with the 'initial soil-moisture content measured by tensiometers and is independent of the total amount of rainfall as well as of the rainfall intensity, provided it does not exceed the infiltration rate of the soil. Consequently, the runoff ratio is a function of the initial soil-moisture content and total rainfall, but not a function of the rainfall intensity. The nondimensional propagation velocity of the wetting front, or inversely, the nondimensional lag of runoff occur-

rence defined by T1* = (T1 x r)/H (where T1 = lag between rainfall and runoff; r = infiltration rate, i.e., rainfall intensity; and H = depth of the lysimeter or distance from the surface to the less pervious layer) also is correlated well with the initial soil moisture. These results are further proven and extended in numerical experiments, solving the Richards equation of unsaturated infiltration. An approximate analytical solution has been derived for the runoff ratio and rainfall loss. (Author's abstract)
W89-05854

INCORPORATION OF THE EFFECT OF CONCENTRATION OF FLOW INTO THE KINEMATIC WAVE EQUATIONS AND ITS APPLICATIONS TO RUNOFF SYSTEM LUMPING,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
T. Takasao, and M. Shiba.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 301-322, September 30, 1988. 24 fig, 1 tab, 15 ref.

Descriptors: *Surface-groundwater relations, *Kinematic wave theory, *Model studies, *Subsurface flow, *Runoff, *Topography, *Reservoir cascade model, *Mathematical analysis, *Hydrologic models, Kinematic waves, Mathematical models, Watersheds, Mountain streams, Networks, Catchment areas.

The usual kinematic wave equations were revised to consider the interaction between surface flow and subsurface flow in mountainous watersheds having curved surfaces covered with A-layers of uniform thickness. A function that represents watershed surface geometry, called the geometric pattern function, was incorporated into the basic equations of the kinematic wave model, and the depth-flow relation equation for the surface-subsurface flow system was derived. When the watershed surface is linearly converging or diverging, its geometric pattern function has a linear form, and numerical simulations for such cases are given. If the geometric pattern function is regarded as a new parameter of the kinematic wave model, then the kinematic wave flow model becomes very flexible. In fact, when the lateral inflow is spatially uniform, the model may be used as a simple model of a stream network system. Using this simplified model, a method was developed for transforming the kinematic wave flow model of a stream system into a lumped runoff model, which is called a 'reservoir cascade' model. (Author's abstract)
W89-05856

EFFECTS OF SLOPE CONDITIONS ON DIRECT RUNOFF CHARACTERISTICS BY THE INTERFLOW AND OVERLAND FLOW MODEL,
Yamanashi Univ., Kofu (Japan). Dept. of Civil Engineering.
K. Sunada, and T. F. Hong.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 323-334, September 30, 1988. 10 fig, 11 ref.

Descriptors: *Rainfall-runoff relationships, *Mathematical models, *Subsurface flow, *Runoff, *Topography, *Catchment areas, *Interflow, *Overland flow, Hydrologic models, Slopes, Spatial distribution, Variable source areas, Kinematic wave theory, Experimental basins.

The variable source area concept is helpful in explaining the runoff producing mechanisms in natural watersheds. It relies on knowledge of spatial distributions of conditions such as slope, length and shape, roughness, and permeability of the surface layers. Topographic effects of a watershed must be considered when analyzing runoff parameters. A numerical runoff model describes interflow and overland flow of variously spatially distributed hillslopes. Kinematic wave theory was applied to the divided partial conical slopes to express more precisely the topographic features of the natural watershed. The mechanisms of the direct runoff processes were examined with hydrologic data of an experimental watershed by the model of interflow and overland flow. The concept of variable source areas was confirmed and the distribution of the source area was exemplified. (Rochester-PTT)
W89-05857

EFFECT OF STORM RAINFALL INTENSITY PATTERNS ON SURFACE RUNOFF,
Agricultural Research Service, Tucson, AZ. Arid-land Watershed Management Research Unit.
For primary bibliographic entry see Field 2A.
W89-05858

SOIL-AQUIFER-STREAM INTERACTIONS: A REDUCTIONIST ATTEMPT TOWARD PHYSICAL-STOCHASTIC INTEGRATION,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05859

EVALUATION OF RAINFALL-RUNOFF MODELS FROM THE STOCHASTIC VIEWPOINT,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05860

PARAMETERIZATION OF REGIONAL EVAPORATION: SOME DIRECTIONS AND STRATEGIES,
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2D.
W89-05861

MODELLING NITRATE REMOVAL BY RIPARIAN VEGETATION IN A SPRINGFED STREAM: THE INFLUENCE OF LAND-USE PRACTICES,
Massey Univ., Palmerston North (New Zealand). Dept. of Mathematics and Statistics.
J. W. Hearne, and C. Howard-Williams.
Ecological Modelling ECMODT, Vol. 42, No. 3/4, p 179-198, September 1988. 10 fig, 2 tab, 18 ref.

Descriptors: *Model studies, *Mathematical models, *Nitrogen removal, *Streams, *Riparian vegetation, *Nitrates, *Land use, New Zealand, Spring water, Nitrogen cycle, Aquatic vegetation, Grazing, Seasonal variation, Differential equations.

Downstream nutrient flux has been modeled in a second-order springfed stream in New Zealand where the stream banks have been protected by the establishment of fenced riparian strips. This has allowed the development of an aquatic stream bank vegetation which assists in the removal of dissolved nitrogen from the stream water. The model comprises a coupled system for first-order, non-linear partial differential equations to incorporate the feedback effects of nitrogen uptake and release as the water moves downstream. The most sensitive parameters in the model were shown to be the growth and mortality constants for the aquatic vegetation. Analysis of varied farming practices on nutrient uptake by the riparian vegetation shows that winter grazing of the system is disadvantageous to nutrient uptake but that grazing at rates 2 to 3 times the regional average can be sustained during summer months without adversely affecting uptake. Decreasing nutrient mass flows at the spring either by altering concentration or discharge would greatly reduce nutrient export when below defined threshold values, and increases in mass flows above these values would increase export proportionately. Nutrient uptake was found to be proportional to concentration only at low flows. (Author's abstract)
W89-05882

SIMPLE WATER BALANCE DAILY RAINFALL-RUNOFF MODEL WITH APPLICATION TO THE TROPICAL MAGELA CREEK CATCHMENT,
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
I. M. Vardavas.
Ecological Modelling ECMODT, Vol. 42, No. 3/4, p 245-264, September 1988. 5 fig, 4 tab, 17 ref.

Descriptors: *Hydrologic models, *Model studies, *Hydrologic budget, *Tropical regions, *Rainfall-runoff relationships, *Streams, Catchment areas, Australia, Evaporation, Discharge measurement.

A simple water balance rainfall-runoff model is presented which uses daily rainfall, averaged over a catchment, and monthly-averaged daily evaporation to predict the daily discharge at the catchment outlet. The model was applied to the large (600 sq km) tropical Magela Creek catchment situated within Kakadu National Park in the wet-dry tropical region of the northern Territory of Australia. The model was validated by its ability to predict the measured daily discharge at the catchment outlet over 4 years, using the chi squared statistic to establish both goodness of fit and as the objective function for model parameter selection. (Author's abstract)
W89-05885

PHYSICAL FRAMEWORK OF THE DEPENDENCE BETWEEN CHANNEL FLOW HYDROGRAPHS AND DRAINAGE NETWORK MORPHOMETRY,
Agricultural Research Service, Fort Collins, CO.
J. Garbrecht, and H. W. Shen.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 337-355, October-December 1988. 11 fig, 4 tab, 27 ref.

Descriptors: *Geomorphology, *Rainfall-runoff relationships, *Channel flow, *Hydrographs, *Drainage networks, *Mathematical studies, *Runoff, *Rainfall, Watersheds, Hortons Law.

The physical basis of the linkage between magnitude and timing of channel flow hydrographs and drainage network morphometry is reviewed. Small Hortonian networks are analyzed using numerical runoff simulation. For Hortonian networks the variability of the geometry if individual channels and subcatchments within each Strahler order has generally little effect upon the overall character of the hydrograph in channels of higher order. If the network is also structurally Hortonian, the analysis of the simultaneous formation, travel, and concentration of the hydrographs in all channels of the network can be simplified to a sequence of one representative hydrograph per channel order. This approach is used in this study. Three major runoff processes control the flow hydrograph characteristics: the overland flow process which determines the water supply to the drainage network; the channel flow process which translates the hydrograph in space and time; and the drainage network process which concentrates and magnifies the flow at the junctions of the drainage network. Functional relations for the hydrograph peak, timing, and flow velocity are presented. For a given uniform rainfall and infiltration rate, the peak of the channel flow hydrograph increases geometrically with channel order, and its magnitude is directly related to the bifurcation ratio. The travel time of the peak also increases geometrically with channel order, and it is directly related to the channel length ratio over velocity ratio. The flow velocity of the peak changes in a downstream direction as a function of the bifurcation and slope ratio. For negligible channel storage the channel flow and drainage network processes do not contribute significantly to the observed nonlinear response of a watershed to precipitation. (Author's abstract)
W89-05889

OVERLAND FLOW ON PERVIOUS, CONVERGING SURFACE,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
A. O. Akan.
Nordic Hydrology NOHYBB, Vol. 19, No. 3, p 153-164, 1988. 5 fig, 1 tab, 18 ref.

Descriptors: *Model studies, *Overland flow, *Mathematical models, *Storm runoff, *Drainage area, Design flow, Discharge, Converging basins, Basins.

A desk-top method based on kinematic overland flow and Green-and-Ampt infiltration models was developed to determine the time of concentration of and the peak runoff rate from a converging basin. The governing equations of the rainfall-infiltration-overland flow process are written in terms of various dimensionless parameters.

Common values of these parameters indicate hydrologic similarity of an infinite number of different converging basins, and therefore the results obtained in terms of these physically-based parameters can be generalized. Using this similarity concept, two charts have been developed to determine the time of concentration of a basin and the peak runoff rate. As illustrated by a sample application, these charts can be used for quick estimates of the design discharge for storm drainage facilities. (Author's abstract)
W89-05901

SEASONAL TRENDS OF ALUMINUM CHEMISTRY IN A SECOND-ORDER MASSACHUSETTS STREAM,
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05926

STREAMFLOW NUTRIENT DYNAMICS ON COASTAL PLAIN WATERSHEDS,
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W89-05942

NEW METHOD FOR THE PREDICTION OF RESISTANCE COEFFICIENTS FOR NATURAL STREAMS,
Yarmouk Univ., Irbid (Jordan). Dept. of Civil Engineering.
A. B. Shahalam, and A. R. Mansour.
Proceedings of the Institution of Civil Engineers, Part 2 PCIEAT, Vol. 85, p 517-531, September 1988. 4 fig, 6 tab, 13 ref.

Descriptors: *Flow resistance, *Streamflow, *Natural streams, *Open channels, Statistical analysis, Correlation coefficient, Resistance coefficient, Prediction.

Methods and procedures used to estimate resistance coefficients for open channels and natural streams are reviewed. Based on the effective size of bed particles, the Manning equation, other workers' equations and data in the literature, a new relationship was developed with a correlation coefficient of 0.87 and standard deviation of 0.97. When the relationship was applied to data collected from Wadi Elwala in Jordan and from other regions, it performed well. The relationship was corrected for variation in flow stage and rate, and for channel slope by developing a new correcting factor. It is recommended that the new relationships be used and tested with additional data collected from different places in the world to check their generality and applicability. (Author's abstract)
W89-05998

RIVER MANAGEMENT TO REDUCE TURBIDITY IN NAVIGABLE BROADLAND RIVERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W89-06005

VOLATILE COMPOUNDS IN FLAVOR-TAINTED FISH FROM THE UPPER WISCONSIN RIVER,
Wisconsin Univ.-Madison. Environmental Toxicology Center.
For primary bibliographic entry see Field 5C.
W89-06013

TOXIC CHEMICAL POLLUTION OF THE ST. LAWRENCE RIVER (CANADA) AND ITS UPPER ESTUARY,
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W89-06023

MULTIOBJECTIVE, DISCRETE SYSTEM REPRESENTATION OF RANGELAND WATERSHEDS,
Maricopa County Flood Control District, Phoenix, AZ.
For primary bibliographic entry see Field 6A.
W89-06059

DETERMINATION OF UNGAGED TRIBUTARY FLOWS AND INTERSEGMENTAL RESERVOIR FLOWS USING SPREADSHEET SOFTWARE,
Wisconsin Univ.-Platteville.
R. L. Dymond, and A. J. McDonnell.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1065-1072, October 1988. 9 fig, 4 tab, 6 ref.

Descriptors: *Streamflow forecasting, *Model studies, *Computer programs, *Computer models, *Stream discharge, *Flow discharge, Computers, Tributaries, Hydrologic models, Reservoirs, Watersheds, Continuity equation.

Spreadsheet software (Lotus 1-2-3) was utilized on two related large scale trial and error water resources problems. Gaged streamflow data and known reservoir volumes were used to construct a daily continuity balance in order to estimate the daily mean flow from ungaged portions of a study watershed over one year. Watershed yield coefficients were determined for two diverse types of watersheds with and without significant groundwater contribution. Subsequently, a spreadsheet template was devised to ensure than an EPA supported water quality model, WASP, would successfully model the actual segmental volumes of a flood control reservoir. Inlet, outlet, and intersegmental advective flows were determined on a two week average basis using a continuity balance, segmental routing, and known segmental volumes. The protocols described relate the use of microcomputers to the resolution of hydraulic and hydrologic problems requiring iterative solutions. (Author's abstract)
W89-06063

SHORT-TERM FORECASTING OF SNOWMELT RUNOFF USING ARMAX MODELS,
Williams (Philip) and Associates, San Francisco, CA.
J. P. Haltiner, and J. D. Salas.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1083-1089, October 1988. 5 fig, 2 tab, 9 ref.

Descriptors: *Model studies, *River forecasting, *Streamflow forecasting, *Runoff forecasting, *Snowmelt, *Armax models, Hydrologic models, Time series analysis.

Time series models of the ARMAX class were investigated for use in forecasting daily riverflow resulting from combined snowmelt/rainfall. The Snowmelt Runoff Model (Martinec-Rango Model) is shown to have a form similar to the ARMAX model. The advantage of the ARMAX approach is that analytical model identification and parameter estimation techniques are available. In addition, previous forecast errors can be included to improve forecasts and confidence limits can be estimated for the forecasts. Diagnostic checks are available to determine if the model is performing properly. Finally, Kalman filtering can be used to allow the model parameters to vary continuously to reflect changing basin runoff conditions. These advantages result in improved flow forecasts with fewer model parameters. (Author's abstract)
W89-06065

WATER QUALITY AFTER LOGGING SMALL WATERSHEDS WITHIN THE BULL RUN WATERSHED, OREGON,
Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.
For primary bibliographic entry see Field 4C.
W89-06067

DISTINCTIVE ATTRIBUTES OF DEBRIS TORRENTS,
British Columbia Univ., Vancouver. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W89-06088

CHANGES IN SEASONAL WATER TRANSPORT IN A LOUISIANA ESTUARY, FOURLEAGUE BAY, LOUISIANA,
Coastal Engineering Research Center, Vicksburg, MS.
For primary bibliographic entry see Field 2L.
W89-06098

EARTHY-MUSTY ODOR-PRODUCING CYANOPHYTES ISOLATED FROM FIVE WATER AREAS IN TOKYO,
Tokyo Metropolitan Research Lab. of Public Health (Japan).
For primary bibliographic entry see Field 5B.
W89-06124

OCCURRENCE OF MUSTY ODOR IN THE YODO RIVER,
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
For primary bibliographic entry see Field 5B.
W89-06126

MACROINVERTEBRATE DISTRIBUTION AND RECOLONIZATION ON STONES SUBJECTED TO VARYING DEGREES OF DISTURBANCE: AN EXPERIMENTAL APPROACH,
Monash Univ., Clayton (Australia). Dept. of Zoology.
A. J. Boulton, G. M. Spangaro, and P. S. Lake.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 551-576, October 1988. 14 fig, 8 tab, 42 ref.

Descriptors: *Macroinvertebrates, *Species diversity, *Flooding, *Aquatic insects, Species composition, *Flood damage, Ecological effects, Streams, Mayflies, Oligochaetes, Algae, Organic matter, Population density, Scour, Chlorophyll a, Population dynamics, Simulation.

The macroinvertebrate distribution on the tops and bottoms of riffle stones was examined in the Taggerty River, Victoria, Australia. Stones were overturned to simulate mild flood effects Overturning stones immediately and significantly reduced the number of taxa and individuals. Highly mobile taxa recovered from such a disturbance within 24 hours while less mobile grazers recovered more slowly (4 days). Colonization of brushed stones (intact epilithon but macroinvertebrate-free) was complete in 8 days while macroinvertebrate densities on acid-scoured stones (mimicking severe flooding) were still less after 32 days than on undisturbed controls--suggesting that the development of epilithon may regulate the rate of colonization by some taxa (e.g. Agapetus spp.). These results strongly suggest that the macroinvertebrate fauna of stream stones is resistant to disturbance and has a high resilience, and that the intensity of disturbance has a strong influence on subsequent faunal composition. (Author's abstract)
W89-06143

DIURNAL VARIATIONS OF CHEMICAL AND PHYSICAL FACTORS IN A RUNNING WATER (SUZE, BERNESE JURA) (TAGESSCHWANKUNGEN CHEMISCHER UND PHYSIKALISCHER FAKTOREN IN EINEM FLIESSGEWAESSER (SCHUESS, BERNER JURA),
Bern Univ. (Switzerland). Zoologisches Inst.
For primary bibliographic entry see Field 5B.
W89-06146

MERCURY CONTAMINATION IN THE AMAZON: A GOLD RUSH CONSEQUENCE,
Centro de Energia Nuclear na Agricultura, Piracicaba (Brazil).
For primary bibliographic entry see Field 5B.
W89-06173

APPLICABILITY OF THE SOIL CONSERVATION SERVICE EQUATIONS FOR RUNOFF

PREDICTION IN THE OTTAWA-ST. LAWRENCE LOWLANDS,
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Agricultural Engineering.
C. A. Madramootoo, and P. Enright.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 759-765, October 1988. 5 tab, 7 fig, 12 ref.

Descriptors: *Rainfall-runoff relationships, *Model studies, *Runoff forecasting, *Runoff rates, *Runoff volume, *Storm runoff, *Surface runoff, Rainfall, Peak flows, Soil Conservation Service model, Lag time, Upland method, Antecedent moisture conditions, Ottawa-St. Lawrence lowlands, Canada, Runoff, Hydrologic models, Mathematical models, Watershed models.

The study was conducted to assess the applicability of the Soil Conservation Service (SCS) equations for runoff prediction in the Ottawa-St. Lawrence lowlands. The equations were developed under climatic, soil, and topographic conditions very much different from this region. An analysis of 13 runoff events showed that time of concentration was underpredicted by empirical formulae and the upland method. There was also considerable variation between measured and predicted lag time. Using antecedent moisture conditions level 2, the SCS triangular hydrograph model generally underpredicted both runoff volume and peak flow. However, increasing the curve number to reflect antecedent moisture conditions level 3 resulted in improper synthesis of the flood hydrograph and gross overprediction of peak flow. It is evident from these results that new criteria for antecedent moisture conditions and hydrologic soil groups must be derived for the Ottawa-St. Lawrence lowlands along with the development of seasonal curve numbers. (Author's abstract)
W89-06240

UNCERTAINTIES IN THE SINGLE DETERMINATION OF RIVER DISCHARGE: A LITERATURE REVIEW,
Environment Canada, Winnipeg (Manitoba). Water Resources Branch.
P. M. Pelletier.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 834-850, October 1988. 5 fig, 142 ref, append.

Descriptors: *Stream discharge, *Discharge measurement, *River flow, *Flow discharge, *Current meters, Flow measurement, *Flow characteristics, Flow pattern, Flow profiles, Velocity-area method, Flow velocity, Canada.

The overall uncertainty in the determination of river discharge, using the velocity-area method, is due to a combination of many sources of uncertainty which include: the determination of the cross-sectional area; the determination of the mean velocity; and the approximation of the integral of a velocity field over a cross section by the finite summations. The uncertainty values found in the reviewed literature do not adequately cover the stream or river types encountered in Canada. The magnitude of various uncertainties may vary depending on the hydraulic and morphologic character of the stream. Those stream types could be classified, for example, as large, medium, and small streams; fast and slow moving streams; large gradient boulder streams; and complete and partial ice-covered streams. Moreover, the uncertainty values given in the literature are often referring to measurements performed under ideal conditions rather than the diverse conditions normally encountered in the field. The following investigations should be undertaken to achieve a better understanding of streamflow measurement: calibration and analysis of current meters; the effect of turbulence on the response of the Price current meter; the uncertainty in a single determination of discharge for Canadian streams; and the uncertainty in the stage-discharge relation and in the computation of the discharge hydrograph. (White-Reimer-PTT)
W89-06244

ROUGHNESS COEFFICIENT IN RIVER CHANNELS,
For primary bibliographic entry see Field 8B.
W89-06272

VARIABILITY OF EMPIRICAL FLOW QUANTILES,
California Univ., Santa Barbara. Dept. of Geography.
For primary bibliographic entry see Field 7C.
W89-06279

SEPARATION AND SIZE CHARACTERIZATION OF COLLOIDAL PARTICLES IN RIVER WATER BY SEDIMENTATION FIELD-FLOW FRACTIONATION,
Chisholm Inst. of Tech., Melbourne (Australia). Water Studies Centre.
For primary bibliographic entry see Field 2J.
W89-06301

DISTRIBUTION OF UPPER AND MIDDLE OHIO RIVER FISHES, 1973-1985: I. ASSOCIATIONS WITH WATER QUALITY AND ECOLOGICAL VARIABLES,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
For primary bibliographic entry see Field 8I.
W89-06318

SIMPLE AND INEXPENSIVE METHOD FOR DETERMINING STREAM DISCHARGE FROM A STREAMBANK,
New York State Museum, Albany.
For primary bibliographic entry see Field 7B.
W89-06320

EFFECTS OF SUBMERSED MACROPHYTES ON WATER QUALITY IN THE TIDAL POTOMAC RIVER, MARYLAND,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 2L.
W89-06321

BENTHIC COMMUNITY METABOLISM IN TWO NORTHERN MISSISSIPPI STREAMS,
Fish and Wildlife Service, Cookeville, TN. Ecological Services Office.
For primary bibliographic entry see Field 2H.
W89-06322

NUTRIENT DYNAMICS OF A SUBMERSED MACROPHYTE COMMUNITY IN A STREAM ECOSYSTEM DOMINATED BY POTAMOGETON PECTINATUS L.,
Rensselaer Polytechnic Inst., Troy, NY. Rensselaer Fresh Water Inst.
For primary bibliographic entry see Field 2H.
W89-06324

BENTHIC MACRO-ALGAE OF GEORGIAN BAY, THE NORTH CHANNEL AND THEIR DRAINAGE BASIN,
Rhode Island Univ., Kingston. Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-06344

EFFECTS OF REGULATED STREAM ON THE HYDROCHEMISTRY AND ZOOBENTHOS IN DIFFERENTLY POLLUTED PARTS OF THE UPPER VISTULA RIVER (SOUTHERN POLAND),
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 5C.
W89-06351

OBSERVATIONS ON THE RELATION BETWEEN PHYTOPLANKTON DIVERSITY AND ENVIRONMENTAL FACTORS IN THE VAAL RIVER AT BALKFONTEIN, SOUTH AFRICA,
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany.
For primary bibliographic entry see Field 5C.
W89-06353

RESPONSE OF MACROINVERTEBRATES TO EXPERIMENTAL EPISODES OF LOW PH WITH DIFFERENT FORMS OF ALUMINUM DURING A NATURAL SPATE,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 5C.
W89-06354

SEASONAL VARIATION IN FAUNAL DISTRIBUTION WITHIN THE SEDIMENTS OF A CANADIAN SHIELD STREAM, WITH EMPHASIS ON RESPONSES TO SPRING FLOODS,
Toronto Univ. (Ontario). Dept. of Zoology.
D. J. Giberson, and R. J. Hall.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1994-2002, November 1988. 5 fig, 1 tab, 29 ref, append. NSERC Grant A9881.

Descriptors: *Acid rain effects, *Seasonal variation, *Aquatic insects, *Invertebrates, *Annual floods, *Stream biota, *Streams, *Sediments, Spring, Canada, Species composition, Midges, Hydrogen ion concentration.

The vertical distribution of invertebrates within the shallow substrates of a Canadian Shield lake outflow stream was examined to determine the importance of season and spate on distribution pattern. Stream invertebrates were found throughout the year to depths of 25 cm below the sediment surface, only about 5 cm above bedrock. Insect abundance showed a strong seasonal pattern, with highest numbers occurring during early winter (December) in all depth zones. Except for Chironomidae, the majority of the insects found below 5 cm were early instar larvae of those found regularly at the surface. Insect abundance was generally higher at the sediment surface than for all other depth zones combined and consisted mainly of one taxon, Prosimulium (Diptera: Simuliidae). Non-insect invertebrates were always more abundant in the hyporheos than at the surface. Total invertebrate abundance (primarily Prosimulium) at the sediment surface decreased by about 40% during the spring snowmelt flood, but no significant changes in abundance occurred in the hyporheos during this period. Chemical analysis of surface and interstitial water showed that both pH and alkalinity decreased slightly in surface waters during the flood, but increased within the hyporheos, particularly on the rising limb of the flood hydrograph. (Author's abstract)
W89-06381

PARTICULATE ORGANIC MATTER EXPORT FROM THREE HEADWATER STREAMS: DISCRETE VERSUS CONTINUOUS MEASUREMENTS,
Georgia Univ., Athens. Dept. of Entomology.
T. F. Cuffney, and J. B. Wallace.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 2010-2016, November 1988. 3 fig, 6 tab, 37 ref.

Descriptors: *Headwaters, *Streams, *Particulate matter, *Streamflow, *Organic matter, Downstream transport, Sampling.

Particulate organic matter (POM) export from 3 small headwater streams of the southern Appalachian Mountains was estimated using continuous and discrete (grab) measurement methods for 2 yr. Total annual POM export estimated from continuous measurements was always greater (28-68 kg ash-free dry mass (AFDM)) than estimates (8-44 kg AFDM) made from discrete measurements (i.e. POM concentration x total discharge). Continuous export samples were collected using a weir and gaging flume connected to a Coshocton proportional sampler designed to deliver 0.6% of discharge into a series of 3 settling barrels. The settling barrels removed a consistent proportion of POM (85-87%). The proportion of stream flow sampled by the Coshocton samplers was constant for each of the samplers (range 0.53-0.6%). The constant extraction efficiencies and proportional sampling of discharge allowed for the calculation of total export independent of discharge measure-

ments (i.e. total export = amount in barrels / Coshocton percentage). The inability of the discrete method to adequately sample storm and bedload transport accounts for the underestimates of total annual export. This underestimation has important implications for studies which use discrete measurements to estimate POM export. (Author's abstract)
W89-06382

SEDIMENT CONTROL OF SOLUBLE REACTIVE PHOSPHORUS IN HOXIE GORGE CREEK, NEW YORK,
State Univ. of New York Coll. at Cortland. Dept. of Biological Sciences.
R. L. Klotz.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 2026-2034, November 1988. 5 fig, 8 tab, 33 ref.

Descriptors: *Phosphorus, *Nutrients, *Phosphorus removal, *Streams, *Sediments, Aluminum, Soil chemistry, New York, Chemical reactions, Streamflow.

Stream sediments regulate the soluble reactive phosphorus (SRP) of stream water by geochemical processes. This conclusion was based on sediment analysis, laboratory sorption experiments, and measurement of the equilibrium phosphorus concentration (EPC). EPC is the concentration of P in the water at which there is neither sorption nor desorption of P by the sediments. At low flow conditions, streamwater SRP was highly correlated with EPC at 6 sites along Hoxie Gorge Creek (r=0.979). EPC was inversely related to the ionic strength of the equilibrating solution, with Ca(2+) producing larger changes than Na(+). Minimum EPC values occurred near the neutral pH of the stream water and increased sharply in acidic and basic solutions. Also, EPC was negatively correlated with the exchangeable Al content of the sediment at the 6 sites. These data are consistent with a mechanism previously verified for soils in which solution cations displace exchangeable Al(III) from sediments: hydrolyzed Al(III) reacts with phosphate and removes it from solution. EPC and streamwater SRP were lower at sites with sediments that had higher concentrations of P-binding sites, despite also having higher sediment P. (Author's abstract)
W89-06384

COMPUTATION OF CRITICAL DEPTH IN SYMMETRICAL COMPOUND CHANNELS,
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
M. H. Chaudhry, and S. M. Bhallamudi.
Journal of Hydraulic Research JHYRAF, Vol. 26, No. 4, p 377-395, 1988. 11 fig, 21 ref.

Descriptors: *Open channel flow, *Channel flow, *Critical depth, *Mathematical models, *Water surface profiles, Symmetrical compound channels.

Critical flows may occur at more than one depth in channels having compound cross-sections (cross-sections with flood plains). The possibility of multiple critical depths affects the water-surface-profile calculations. Presently available algorithms determine only one of the critical depths that may lead to large errors. Computational procedures are presented for computing all the possible critical depths in general symmetrical, compound channels. They incorporate a general definition of Froude number based on the one-dimensional unsteady momentum and continuity equations. In these procedures, the total number of critical depths possible in a cross-section for a given discharge are first determined and then their values are computed one by one in an efficient manner. A procedure is presented to design a compound channel section so that there is only one critical depth, thereby reducing the range of flow depth over which flow may be highly unstable. Two typical examples are presented to illustrate the effect of multiple critical depths on the water-surface profile computations: (1) a long channel with a free overfall at the downstream end and (2) a long channel with a reservoir at the upstream end. (Brock-PTT)
W89-06398

IMPROVED FOUR-POINT SOLUTION OF THE KINEMATIC EQUATIONS,
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
A. P. Holden, and D. Stephenson.
Journal of Hydraulic Research JHYRAF, Vol. 26, No. 4, p 413-423, 1988. 5 fig, 14 ref.

Descriptors: *Kinematic wave theory, *Finite difference methods, *Overland flow, *Mathematical models, Kinematic equations, Four-point solution, Streamflow, Routing.

In finite difference solutions of the kinematic equations for overland flow, uncontrolled numerical diffusion can be introduced into a system by the finite difference scheme. A formulation for overland flow based the Muskingum-Cunge routing procedure incorporating a four-point numerical scheme is described and the results of numerical experiments are presented, comparing the method with other kinematic routing methods. The experiments verify the dependence of kinematic routing accuracy on grid spacing and on the position of the space derivative, and show that the Muskingum-Cunge results are independent of grid spacing. By comparing the conventional formulation, it is shown that a centered scheme is the most appropriate for overland flow routing if a fixed grid formulation of the kinematic equations is employed. (Author's abstract)
W89-06399

PREDICTION OF FLOW CHARACTERISTICS IN MAIN CHANNEL/FLOOD PLAIN FLOWS,
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-06400

SOURCE AREAS CONTRIBUTING TO THE EPISODIC ACIDIFICATION OF A FORESTED HEADWATER STREAM,
Pennsylvania State Univ., University Park. Forest Resources Lab.
For primary bibliographic entry see Field 5B.
W89-06431

PRELIMINARY OBSERVATIONS OF STREAMFLOW GENERATION DURING STORMS IN A FORESTED PIEDMONT WATERSHED USING TEMPERATURE AS A TRACER,
Geological Survey, Doraville, GA.
For primary bibliographic entry see Field 2A.
W89-06434

APPLICATION OF SIMPLE SOIL-WATER FLOW MODELS TO THE TRANSFER OF SURFACE-APPLIED SOLUTES TO STREAMS,
Sheffield Univ. (England). Dept. of Geology.
For primary bibliographic entry see Field 5B.
W89-06435

IMPACT OF BIOLOGICAL ACTIVITY ON DETRITUS TRANSPORTED IN THE LOWER RIVER RHINE: AN EXERCISE IN ECOSYSTEM ANALYSIS,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
For primary bibliographic entry see Field 2H.
W89-06447

RAPID FLOW THROUGH THE SEDIMENTS OF A HEADWATER STREAM IN THE SOUTHERN APPALACHIANS,
Georgia Univ., Athens. Inst. of Ecology.
N. L. Munn, and J. L. Meyer.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 235-240, October, 1988. 4 fig, 1 tab, 19 ref. National Science Foundation Grant BSR 8514328.

Descriptors: *Surface-groundwater relations, *Underflow, *Sediments, Nutrients, Chlorides, Infiltration, Dye releases, Tracers, Stream biota, Absorption, Flow characteristics, Flow measurement, Streams, Headwaters, Appalachian Mountains.

The flow of water through the sediment layer (underflow) of streams can influence nutrient uptake dynamics and the supply of materials to microbes, meiofauna and macroinvertebrates living within stream sediments. This study examined the extent of underflow in Hugh White Creek, a headwater stream in the southern Appalachian Mountains and compared underflow at different depths and at different sites within the stream. Initially rhodamine dye was used to trace the flow of water through the sediments; however, the dye was strongly absorbed by the sediments in Hugh White Creek. Thus rhodamine was not suitable as a tracer of water flow. Chloride reacted conservatively in laboratory experiments and was used as a tracer. The tracer infiltrated the sediments within 5 min to depths of 10 cm at all 6 sites. Chloride infiltration tended to decrease with depth of sediments at all sites although there was no consistent statistical pattern in chloride concentration with depth for the different sites. Equilibrium between the water column and sediments was reached rapidly, within minutes for the sites with coarse sediments and within a few hours for sites with finer sediments. Minimum rater of chloride infiltration into the sediments ranged between 1.0 cm/min for the sites with cobble substrate to 0.2 cm/min for sites with fine sand sediments associated with debris dams. These data suggest that underflow may be a major component in the functioning of Appalachian mountain streams. (Author's abstract)
W89-06448

MICRO-DISTRIBUTION OF AQUATIC MACROINVERTEBRATES IN THE WYE RIVER SYSTEM: THE RESULT OF ABIOTIC OR BIOTIC FACTORS,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 2H.
W89-06449

PLANKTONIC BLOOM-FORMING CYANOBACTERIA AND THE EUTROPHICATION OF LAKES AND RIVERS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.). Dept. of Limnology.
For primary bibliographic entry see Field 2H.
W89-06450

COMPLEX MARKOV MODELS TO SIMULATE PERSISTENT STREAMFLOWS,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
M. Bayazit, and A. Bulu.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 199-207, November 30, 1988. 1 fig, 9 tab, 10 ref.

Descriptors: *Rainfall-runoff relationships, *Markov process, *Streamflow, *Model studies, *Low flow, *Correlation coefficient, Simulation analysis, Correlation analysis, Mathematical studies, Stochastic process, Sweden.

Highly persistent dry periods of certain streams cannot be simulated by simple Markov models which use the observed values of the autocorrelation coefficients. Such streamflow series may, however, be modelled by assuming that the lag-one autocorrelation coefficient is a function of the flow magnitude, while preserving the observed overall value of the coefficient. Run-length characteristics and transition probabilities of such models are investigated by simulation of three different types of autocorrelation functions in relation to flow magnitude. It is shown that these models, named complex models I, II, and III, can simulate persistent low flows as well as the phenomenon of differential persistence. Complex Markov model III is used to describe the annual flows of the river Goeta at Vaenern, Sweden for the period 1807-1964. (Author's abstract)
W89-06454

EFFECT OF BASEFLOW SEPARATION PROCEDURES ON SURFACE RUNOFF MODELS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
B. C. Bates, and P. K. Davies.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 309-322, November 30, 1989. 5 fig, 6 tab, 12 ref.

Descriptors: *Surface-groundwater relations, *Surface runoff, *Base flow, *Mathematical models, *Flood forecasting, *Rainfall-runoff relationships, Streamflow, Sensitivity analysis, Case studies.

The effect of baseflow separation procedures on nonlinear surface runoff models in situations where baseflow makes a substantial contribution to flood hydrographs is examined. Maximum a posteriori (MAP) estimation was used to optimize the parameters of nonlinear surface runoff models. The nonlinear runoff routing model described by Laurenson and Mein (1983) was used on two catchments within the same river basin (Bancell Brook and Tallanalla Creek). Results indicate that the sensitivity of the model parameters, fit, and predictions to the separation procedure chosen is dependent upon whether the model has a highly nonlinear or an approximately linear response. Highly nonlinear models exhibit a marked sensitivity. However, this sensitivity does not appear to carry through to predictions for very large floods. It is suggested that the generality of these findings be checked by considering different surface runoff models and baseflow separation procedures, and other hydrologic regimes in which baseflow forms a major component of streamflow. (Geiger-PTT)
W89-06461

STREAMFLOW AND STREAM SALINITY IN A SMALL WATER SUPPLY CATCHMENT IN SOUTHWEST WESTERN AUSTRALIA AFTER REFORESTATION,
Water Authority of Western Australia, Perth.
H. Borg, R. W. Bell, and I. C. Loh.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, November 30, 1989. 5 fig, 2 tab, 15 ref.

Descriptors: *Forest management, *Water quality control, *Salinity, *Streamflow, *Australia, *Vegetation effects, *Reforestation, *Watershed management, Vegetation establishment, Saline water, Reservoirs, Small watersheds.

In the mid-1970's high salinities developed in the Padbury reservoir in southwest Western Australia due to the conversion of 80% of its catchment from native forest to farmland in previous decades. Between 1977 and 1983 some 70% of this farmland was planted with pines and eucalypts. Most of the slopes were reforested, but only some of the valleys. In 1978 a gauging station was established in the catchment to monitor the effect of reforestation on streamflow and stream salinity. Results obtained to the end of 1986 are presented. Reforestation led to a substantial and continuous reduction in streamflow. There was also a steady reduction in salt discharge from the catchment. In most years the reduction in streamflow outweighed the reduction in salt discharge. Stream salinity was therefore generally higher than it would have been without reforestation. Since 1978, when hydrologic monitoring began, the annual rainfall was generally below the long-term mean of 880 mm, and often below 800 mm. While these dry conditions were at least partly responsible for the increases in stream salinity, it is not known whether salinity would have decreased in all years if the rainfall had been normal. It is argued that completely replanting the valleys would have resulted in lower stream salinities. If rainfall had been normal, or if the valleys had been planted, and particularly with a combination of the two, reforestation may have resulted in a general decrease in stream salinity. Yet, any salinity benefit due to reforestation must be balanced against the concurrent reduction in streamflow. For a small water supply catchment like the one described here, reforestation may not be an appropriate strategy to alleviate salinity problems. However, it is shown that reforestation is useful in large salt-affected catchments in the region where the areas which contribute most of the salt generate only little of the streamflow. (Author's abstract)
W89-06462

NATURE OF SOLUTE TRANSPORT IN THE GODAVARI BASIN, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W89-06466

NUMERICAL SIMULATION OF THE 1981 SICHUAN FLOOD: PART I, EVOLUTION OF A MESOSCALE SOUTHWEST VORTEX,
National Center for Atmospheric Research, Boulder, CO.
For primary bibliographic entry see Field 2B.
W89-06485

CHANNEL HYDRAULICS, HABITAT USE, AND BODY FORM OF JUVENILE COHO SALMON, STEELHEAD, AND CUTTHROAT TROUT IN STREAMS,
Weyerhaeuser Co., Tacoma, WA.
For primary bibliographic entry see Field 2H.
W89-06507

CALIBRATION, SENSITIVITY AND VALIDATION OF A PHYSICALLY-BASED RAINFALL-RUNOFF MODEL,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2A.
W89-06514

THEORY OF RUNS WITH APPLICATIONS TO DROUGHT PREDICTION,
Texas Univ., Houston. School of Public Health.
L. A. Moye, A. S. Kapadia, I. M. Cech, and R. J. Hardy.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 127-137, November 15, 1988. 1 fig, 3 tab, 12 ref.

Descriptors: *Forecasting, *Statistical methods, *Drought, *Prediction, Probability distribution, Estimating, Precipitation, Rainfall, Texas.

Although statistical run theory is a useful tool, its application to the prediction of drought likelihood has met with limited success. A pertinent probability distribution was developed based on difference equations, beginning from the rudiments of run theory. This distribution allows the hydrologist to estimate the expected number of droughts of a prespecified duration, and the average drought length over the desired time period. The applicability of this new mathematical approach was demonstrated using precipitation records for different climatic regions of Texas. This new mathematical approach has three advantages. First, it offers an exact solution for the prediction of the future occurrence of runs of an arbitrary length in a sequence of Bernoulli trials, with no approximations required. Second, the solution is in terms of parameters with which the hydrologist is familiar and has access. Third, the outcome measures of the model are measures of hydrologic importance. Thus, starting from estimates of familiar parameters and using this model, the hydrologist will gain a pertinent, accurate assessment of the likelihood of droughts in the region of interest. (Doria-PTT)
W89-06516

LINEAR MODELS FOR RIVER FLOW ROUTING ON LARGE CATCHMENTS,
University Coll., Galway (Ireland). Dept. of Engineering Hydrology.
G. C. Liang, and J. E. Nash.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 157-188, November 15, 1988. 8 fig, 6 tab, 14 ref, append.

Descriptors: *River flow, *Input-output analysis, *Hydrologic models, *Flood routing, *Routing, *Yangtze River, *China, Flow, Hydrology, Mathematical analysis, Rivers, Tributaries, Catchment areas, Forecasting, Rainfall, Seasonal variation.

The place of linear input-output models in applied hydrology is reviewed, and the algebraic analysis of multiple input-single output linear systems is presented and applied in the context of flood routing on the Yangtze River in China. Two different stretches of the river and one tributary catchment were chosen and the outflows forecast in terms of observed flows at the upper ends of the river reaches and rainfall on the intervening catchment. It is shown that very high accuracy can be obtained with multiple input linear models whether applied to the total flows and rainfall or to the departures in these quantities from their seasonal expectations. The residual errors which could provide the basis of an updating procedure if the linear models were used for forecasting purposes were analyzed. It is concluded that linear transformation and combination of each of the several input components seems to provide an adequate representation of the catchment's effect in transforming and combining the input functions. The impulse response obtained for each of several inputs may be unstable in its shape and in all cases a constraint to the gamma function form involved very little loss of generality. It is evident that for long series of inputs and outputs the shape of the pulse response is not well defined, or alternatively not very critical. There is little evidence of nonlinearity or of seasonality in the residuals, but what is there can be used to modify the model forecasts. In the examples, the results obtained were of such a high degree of accuracy that updating procedures would not be required, but if these were required it would seem that they could be built on an analysis of the residuals for persistence. (Doria-PTT)
W89-06518

FISH COMMUNITIES AND ENVIRONMENTAL CHARACTERISTICS OF TWO LOWLAND STREAMS IN COSTA RICA,
For primary bibliographic entry see Field 2H.
W89-06535

DISCRIMINATION OF FACTORS INFLUENCING BIOTA OF A STREAM RECEIVING MULTIPLE-SOURCE PERTURBATIONS,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
For primary bibliographic entry see Field 5C.
W89-06536

FLOODING IN THE DESERT: TAKING CONTROL,
Black and Veatch, Las Vegas, NV.
For primary bibliographic entry see Field 4A.
W89-06550

EFFECT OF HIGHER AQUATIC PLANTS ON MICROBIOLOGICAL INDEXES OF WATER QUALITY IN THE PRESENCE OF DECOMPOSED ORGANIC MATTER IN SUSPENSION (VLIYANIE VYSHIKH VODNYKH RASTENII NA MIKROBIOLOGICHESKIE POKAZATELI KACHESTVA VODY PRI DESTRUKTSII RASTVORENNOGO ORGANICHESKOGO VESHCHESTVA),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 2H.
W89-06559

CORRELATION BETWEEN PHYTOPLANKTON PRODUCTION AND ORGANIC MATTER DECOMPOSITION IN THE DANUBE, THE SASYK-DANUBE CANAL, AND THE SASYK RESERVOIR (SOOTNOSHENIE PRODUKTSU FITOPLANKTONA I DESTRUKTSII ORGANICHESKOGO VESHCHESTVA V DUNAI, KANALE DUNAI-SASYK I SASYKSKOM VODOKHRANILISHCHE),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
For primary bibliographic entry see Field 2H.
W89-06562

IMPROVED METHODOLOGY FOR SHORT-TERM OPERATION OF A SINGLE MULTI-PURPOSE RESERVOIR,

Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W89-06574

AUSTRALIAN RIVERS AND STATUTE LAW,
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
For primary bibliographic entry see Field 6E.
W89-06591

NATIONAL SURFACE WATER SURVEY. NATIONAL STREAM SURVEY PHASE I. PILOT SURVEY--SUMMARY OF QUALITY ASSURANCE DATA RESULTS,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-06646

GUIDELINES FOR DETERMINING FLOOD FLOW FREQUENCY.
Geological Survey, Washington, DC. Office of Water Data Coordination.
For primary bibliographic entry see Field 7C.
W89-06662

NUMERICAL MODEL FOR THREE-DIMENSIONAL HYDRODYNAMIC TRANSPORT: DOCUMENTATION OF THE COMPUTER PROGRAM,
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5B.
W89-06675

MODELLING STREAM ACIDITY IN U.K. CATCHMENTS,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W89-06693

TRACE ORGANIC ANALYSIS OF SUSPENDED SEDIMENTS WITH AN IN-STREAM COMPOSITE SAMPLER: THE NEED FOR A STANDARD METHOD,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
For primary bibliographic entry see Field 5A.
W89-06724

FATE AND TRANSPORT OF ORGANIC COMPOUNDS IN RIVERS. 1: SELECTION OF STUDY SITE AND VALIDATION OF SAMPLING AND ANALYTICAL PROCEDURES,
Water Research Centre, Medmenham (England). Medmenham Lab.
For primary bibliographic entry see Field 5B.
W89-06770

POLYCHLORINATED BIPHENYLS IN THE KUPA RIVER, CROATIA, YUGOSLAVIA,
Sisak Medical Center (Yugoslavia). Dept. of Sanitary Chemistry.
For primary bibliographic entry see Field 5B.
W89-06776

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES FROM URBAN BASINS IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
L. D. Becker.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4322, 1986. 38p, 16 fig, 4 tab, 26 ref.

Descriptors: *Flood peak, *Peak discharge, *Urban drainage, *Missouri, *Rainfall-runoff relationships, *Flood forecasting, Flood data, Regression analysis, Mathematical studies, Hydrologic models, Model studies, Statistical analysis, Catchment areas, Estimating.

Techniques are defined for estimating the magnitude and frequency of future flood peak discharges of rainfall-induced runoff from small urban basins in Missouri. These techniques were developed from an initial analysis of flood records of 96 gaged sites in Missouri and adjacent states. Final regression equations are based on a balanced, representative sampling of 37 gaged sites in Missouri. This sample included 9 statewide urban study sites, 18 urban sites in St. Louis County, and 10 predominantly rural sites statewide. Short-term records were extended on the basis of long-term climatic records and use of a rainfall-runoff model. Linear least-squares regression analyses were used with log-transformed variables to relate flood magnitudes of selected recurrence intervals (dependent variables) to selected drainage basin indexes (independent variables). For gaged urban study sites within the State, the flood peak estimates are from the frequency curves defined from the synthesized long-term discharge records. Flood frequency estimates are made for ungaged sites by using regression equations that require determination of the drainage basin size and either the percentage of impervious area or a basin development factor. Alternative sets of equations are given for the 2-, 5-, 10-, 25-, 50-, and 100-yr recurrence interval floods. The average standard errors of estimate range from about 33% for the 2-yr flood to 26% for the 100-yr flood. The techniques for estimation are applicable to flood flows that are not significantly affected by storage caused by manmade activities. Flood peak discharge estimating equations are considered applicable for sites on basins draining approximately 0.25 to 40 sq mi. (Author's abstract)
W89-06831

RELATION OF STREAMFLOW TO HABITAT FOR ANADROMOUS FISH IN THE STILLAGUAMISH RIVER BASIN, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
S. S. Embrey.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4326, 1987. 115p, 30 fig, 35 tab, 20 ref, 3 append.

Descriptors: *Instream flow requirements, *Streamflow, *Anadromous fish, *Stillaquamish River, *Washington, *Fish behavior, Discharge frequency, Salmon, Trout, Stream fisheries, Jim Creek, Squire Creek, Pilchuck Creek, Fish hatcheries, Chum.

The techniques of Instream Flow Incremental Methodology were used to determine the habitat available over a range of simulated streamflows for anadromous fish in certain reaches of streams in the Stillaguamish River basin, Washington. The stream discharge-habitat relations were used to identify that discharge termed the optimum discharge, which provides maximum habitat, for a particular species and life stage of fish. Optimum discharges varied throughout the Stillaguamish River basin because each discharge-habitat relation was unique. The mainstem of the Stillaguamish River is used primarily as a migration route by anadromous fish, but it is also used by chinook and coho salmon and steelhead trout for rearing and by steelhead adults and pink salmon for spawning. Optimum discharges, in cu ft/sec, ranged as follows in the mainstem Stillaguamish River: chinook fry, 600; steelhead--juveniles, 1,000, adults, 2,000, coho juveniles, 400; and pink spawning, 800. The North Fork Stillaguamish River is used for spawning and rearing by all the study fish species. Optimum discharges there were: chinook--spawning, 500 to 1,300, fry, 150 to 400; coho--spawning, 500 to 700, juveniles and fry, 50 to 200; steelhead--adults, 500 to 1,170, spawning, 800 to 900, fry, 50 to 140, juveniles, 300 to 500, chum spawning, 200 to 600; pink spawning, 300 to 600. All the study species spawn and rear in the South Fork Stillaguamish River, but coho spawn and rear fry only at the most upstream study site and chum spawn only at the most downstream site. Optimum discharge ranges on the South Fork were: chinook--spawning, 300 to 900, fry, 70 to 300; coho juveniles, 50 to 100; steelhead--adults, 300 to 900; spawning, 250 to 1,200, fry, 45 to 1,600, juveniles 200 to 500, pink spawning, 100 to 1,200; coho--spawning, 140, fry, 50; chum spawning, 100. Four tributary streams are used by all species except Pilchuck and Canyon Creeks, which are not used by chum salmon. Optimum discharges for all tributary streams ranged as follows: chinook--spawning, 170 to 750, fry 50 to 170; coho--spawning, 90 to 350, fry 20 to 80, juveniles, 35 to 130; steelhead--adults, 170 to 500, spawning, 130 to 400, fry, 20 to 70, juveniles, 70 to 350; pink spawning, 70 to 300; chum spawning in Squire Creek and Jim Creek, 70 to 450. Water temperatures measured in late summer at all sites ranged between 14.5 to 17.5 C. (Lantz-PTT)
W89-06832

ANALYSIS OF WATER-SURFACE PROFILES IN LEON COUNTY AND THE CITY OF TALLAHASSEE, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
M. A. Franklin, and R. A. Orr.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4327, 1987. 82p, 22 fig, 3 tab, 9 ref.

Descriptors: *Florida, *Tallahassee, *Flood profiles, *Surface waters, Lake Munson, Lake Lafayette, Lake Jackson, Regression analysis, Statistical analysis, Floods, Flood peak, Gum Creek.

Water surface profiles for the 10-, 25-, 50-, and 100-yr recurrence interval floods for most of the streams that drain developing areas of Leon County and the city of Tallahassee are presented. The principal streams studied are in the Lake Munson, Lake Lafayette, and Lake Jackson basins Peak discharges were computed from regression equations based on information gained from 15 streamflow stations in the area. Standard step-backwater procedures were used to determine the water-surface elevations for the streams. The flood elevations were generally higher than those in the Flood Insurance Studies for Tallahassee (1976) and Leon County (1982). The primary reason for the higher profiles is that peak discharges used in this report are larger than those used previously, largely due to changes in land use. The flood profiles for Bradford Brook, North Branch Gum Creek, and West Branch Gum Creek generally match those in the Leon County Flood Insurance Studies. Channel improvements in some areas would lower the flood elevation in that area, but would probably increase flooding downstream. (Lantz-PTT)
W89-06833

MAGNITUDE AND FREQUENCY OF FLOODS IN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
B. L. Neely.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4335, 1987. 51p, 14 fig, 6 tab, 13 ref.

Descriptors: Data interpretation, *Flood frequency, *Arkansas, *Streamflow, *Flood forecasting, *Arkansas River, *Mississippi River, Ouachita River, White River, Black River, Flood peak, Mathematical equations, Regression analysis, Mathematical studies, River flow, Red River.

The magnitude and frequency of peak discharges on streams in Arkansas, were estimated through the use of comprehensive regression analyses, in which physical characteristics of streams were related to flood characteristics at gaging stations. Equations derived from the regression analyses provide estimates of peak discharges with selected recurrence intervals from 2 to 100 yrs on streams that have drainage areas < 3,000 sq mi. The regression analyses indicate that size of drainage area, slope of the main channel, length of the main channel, elevation of the basin, and mean annual precipitation were the most significant basin and climatic characteristics that affect the magnitude and frequency of floods. A technique is presented for estimating a stage-discharge relation at un-

gaged sites based on a cross section determined from topographic maps. This cross-section and stage-discharge relation is then used to determine the hydraulic radius for the discharges at each recurrence interval. Techniques are presented for estimating the magnitude and frequency of peak discharges using the hydraulic radius with other physical characteristics of the basin. The techniques that use the hydraulic radius give standard errors of estimate from 5% to 16% lower than techniques that do not use hydraulic radius. Data from 200 gaging stations with drainage areas less than 3,000 sq mi and with at least 10 yrs of record were used in the analyses. Large rivers such as the Red, Arkansas, White, Black, St. Francis, Mississippi, and Ouachita Rivers have flood flow characteristics that differ from those of smaller tributary streams and were, therefore, treated individually. Regional regression equations are not applicable to the large rivers; the magnitude and frequency of floods along these rivers are based on station data. A method is described for estimating the magnitude and frequency of peak discharges on streams for urban areas in Arkansas. (Lantz-PTT)
W89-06835

VERIFICATION OF REGRESSION EQUATIONS FOR ESTIMATING FLOOD MAGNITUDES FOR SELECTED FREQUENCIES ON SMALL NATURAL STREAMS IN GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
M. Price, and G. W. Hess.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4337, 1986. 39p, 10 fig, 4 tab, 1 plate, 10 ref. Georgia Department of Transportation Project 7501.

Descriptors: *Peak flow, *Data interpretation, *Flood peak, *Streams, *Georgia, *Flood frequency, *Regression analysis, Stream gages, Statistical analysis, Mathematical studies, Simulation analysis, Statistical methods.

In 1976 the U.S. Geological Survey, in cooperation with the Georgia Department of Transportation, began a program to monitor small natural streams in Georgia to verify the accuracy of the flood frequency estimating equations for the five flood frequency regions that were published in a previous study. Data collection consisted of obtaining an additional 10 yr of annual peak flow records at 24 gaging stations and establishing and collecting annual peak flow records at 15 additional gaging sites in areas of the State where data were unavailable. Data also were collected for an additional 10 yr at four gaging stations that were converted to continuous record gaging stations in 1976. The flood frequency equations were verified by comparing the observed and regression equation estimated discharges for the 2-, 25-, and 100-yr floods: (1) for the 28 gaging stations continued an additional 10 yr; (2) for the 15 gaging stations that have about 10 yr of record where data were unavailable; and (3) for all gaging stations on drainage areas of < 50 sq mi for which data were available in all five flood frequency regions. The rainfall-runoff model simulated discharges from the previous study also were verified by comparisons of the observed and the rainfall-runoff model simulated discharges for the 2-, 25-, and 100-yr floods for gaging stations calibrated in the previous study. These comparisons, based on student's t-test statistics at the 0.05 level of significance, indicated that all the flood frequency equations computed in the previous study are valid and unbiased except for Regions 2 and 3, where the equations appear to be slightly biased. The comparison of the discharges simulated by the rainfall-runoff model with the observed discharges for the gaging stations that have 20 yr of record were unbiased, but simulated discharges for stations having 10 yr of record were biased, probably because of 'loss of variance' in the averaging procedures of the rainfall-runoff model and the short length of record. The flood-frequency estimating equations computed in the previous study have been verified and are considered to be valid for natural streams in Georgia that have drainage areas of 0.1 to 20 sq mi. (Author's abstract)
W89-06837

LOW-FLOW-FREQUENCY CHARACTERISTICS FOR CONTINUOUS-RECORD STREAMFLOW STATIONS IN MINNESOTA,
Geological Survey, St. Paul, MN. Water Resources Div.
A. D. Arntson, and D. L. Lorenz.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4353, 1987. 15p, 1 fig, 2 tab, 9 ref, 2 append.

Descriptors: *Streamflow, *Low flow, *Minnesota, Graphical analysis, Flow discharge, Flow profiles, Statistical analysis, Hydrologic data collections, Hydrologic data.

Annual and summer (May 1 to September 30) low-flow frequency curves are presented for 175 continuous-record streamflow stations in Minnesota. The curves were developed for all stations with 10 or more years of continuous record. The 1-, 7-, and 30-day low-flow discharges at selected recurrence intervals obtained from these curves are listed. Low-flow characteristics can and will vary for a station depending upon the number of years of record and the period gaged. When comparing low-flow characteristics between two or more stations, it should be remembered that no provisions were made to use concurrent periods of record for stations along the same stream. (Lantz-PTT)
W89-06842

ALTERNATIVE BASIN CHARACTERISTIC FOR USE IN ESTIMATING IMPERVIOUS AREA IN URBAN MISSOURI BASINS,
Geological Survey, Rolla, MO. Water Resources Div.
R. E. Southard.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4362, 1986. 21p, 4 fig, 3 tab, 13 ref.

Descriptors: *Urban runoff, *Urban hydrology, *Hydrologic studies, *Urban areas, *Missouri, *Flood peak, Statistical analysis, Regression analysis, Urban planning, Streamflow, Population density, Impervious boundaries, Drainage area.

A previous regression analysis of flood peaks on urban basins in St. Louis County, Missouri, indicated that the basin characteristics of percentage of impervious area and drainage area were statistically significant for estimating the 2-, 5-, 10-, 25-, 50-, and 100-yr peak discharges at ungaged urban basins. In this statewide regression analysis of the urban basins for Missouri, an alternative basin characteristic called the percentage of developed area was evaluated. A regression analysis of the percentage of developed area (independent variable), resulted in a simple equation for computing percentage of impervious area. The percentage of developed area also was evaluated using flood-frequency data for 23 streamflow gaging stations, and the use of this variable was determined to be valid. Using nationwide data, an urban basin characteristic known as the basin development factor was determined to be valid for inclusion in urban regression equations for estimating flood flows. The basin development factor and the percentage of developed area were compared for use in regression equations to estimate peak flows of streams in Missouri. The equations with the basin development factor produced peak flow estimates with slightly smaller average standard errors of estimate than the equation with the percentage of developed area; however, this study indicates that there was not enough statistical or numerical difference to warrant using the basin development factor instead of the percentage of developed area in Missouri. The selection of a basin characteristic to describe the physical conditions of a drainage basin will depend not only on its contribution to accuracy of regression equations, but also on the ease of determining the characteristics; the percentage of developed area has this advantage. A correlation analysis was made by correlating drainage area to percentage of impervious area, the percentage of developed area, and the basin development factor. The results of the analysis indicate that the three basin characteristics are independent of drainage area and appropriate to use in multiple-regression analysis. (Author's abstract)
W89-06848

QUANTITY AND QUALITY OF STREAMFLOW IN THE WHITE RIVER BASIN, COLORADO AND UTAH,
Geological Survey, Lakewood, CO. Water Resources Div.
J. M. Boyle, K. J. Covay, and D. P. Bauer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4022, 1987. 84p, 31 fig, 11 tab, 8 ref.

Descriptors: *River basins, *Water resources data, *Water quality, *Streamflow, *Colorado, *Utah, Flow profiles, Seasonal variation, Surface-groundwater relations, Calcium, Sodium, Dissolved solids, Snowmelt, Runoff.

The water quality and flow of existing streams in the White River basin, located in northwestern Colorado and northeastern Utah, are adequate for present uses, but future development (such as energy) may affect stream quality and quantity. Present conditions are described as a baseline to enable planners to allocate available water and to measure changes in quantity and quality of water in the future. The White River basin contains extensive energy resources consisting of oil, natural gas, coal, and oil shale. Large quantities of water will be required for energy-resource development and associated municipal and industrial uses. An average of 70% of the annual flow in the White River occurs during May, June, and July as a result of snowmelt runoff. The 7-day, 10-year low-flow discharges/sq mi and the 1-day, 25-year high-flow discharges/sq mi are larger in the eastern part of the basin than in the western part. Flow-duration curves indicate that high flows in the White River and the North and South Fork White Rivers result mainly from snowmelt runoff and that base flow is sustained throughout the year by groundwater discharge from the alluvial and bedrock aquifers. Water type varies in the basin; however, calcium and sodium are the dominantly occurring cations and sulfate and bicarbonate are the dominantly occurring anions. Computed total annual dissolved-solids loads in the White River range from 31,800 tons/yr in the North Fork White River to 284,000 tons/yr at the mouth. A 10% increase to a 14% decrease of the dissolved-solids load could result at the mouth of the White River near Ouray, Utah. This corresponds to a 5% increase to a 10% decrease in dissolved-solids concentration. The seasonal pattern of stream temperatures was found to fit a harmonic curve. (Lantz-PTT)
W89-06854

EVALUATION OF THE COST EFFECTIVENESS OF THE 1983 STREAM-GAGING PROGRAM IN KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 6C.
W89-06859

ANALYSIS OF CHARACTERISTICS OF SIMULATED FLOWS FROM SMALL SURFACE-MINED AND UNDISTURBED APPALACHIAN WATERSHEDS IN THE TUG FORK BASIN OF KENTUCKY, VIRGINIA, AND WEST VIRGINIA,
Geological Survey, Reston, VA. Water Resources Div.
A. G. Scott.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4151, 1984. 169p, 24 fig, 8 tab, 10 ref, 2 append.

Descriptors: *Mine drainage, *Small watersheds, *Model studies, *Land use, *Flow profiles, *Simulation analysis, *Surface-groundwater relations, *Hydrologic data collections, *Kentucky, *Virginia, *West Virginia, Stream discharge, Graphical analysis, Statistical analysis, Regression analysis, Flow discharge, Flood frequency.

Hydrologic and climatologic data were collected at eight small mined and two small unmined watersheds. These data included: continuous records of discharge, precipitation, and air temperature; daily records of sediment concentrations and sediment discharge; and periodic observations of water quality. Tables of all these data are presented in this report. The observed climatic and hydrologic data from these basins were used to calibrate the U.S. Geological Survey Precipitation-Runoff Modeling System for each watershed. The calibrated models of each basin were then used with a set of nearby, long-term climatic data to simulate a 68-year record of daily streamflow and 57 years of annual peaks at each site. These simulated records were analyzed to obtain flood frequency curves, flow duration curves, mean annual discharges, and the 7-day, 10-year low flow for each site. The flow characteristics computed from the simulated records of discharge were analyzed graphically, and statistically by regression analysis, to investigate the relationship between mining and runoff. For this sample of small basins, peak flows, discharges for 10- and 50-percent flow durations, and mean annual flows were found to be directly related to percent of drainage area disturbed and drainage area. Percent of drainage area disturbed was generally a more statistically significant estimator of discharges than drainage area, particularly for those peak flows of higher recurrence intervals. (Author's abstract)
W89-06861

STREAMFLOW GAIN-AND-LOSS AND SUSPENDED-SEDIMENT CHARACTERISTICS OF THE SOUTH PLATTE RIVER AND THREE IRRIGATION CANALS NEAR FORT MORGAN, COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
B. C. Ruddy.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4220, 1984. 82p, 4 fig, 18 tab, 13 ref.

Descriptors: *Irrigation effects, *Surface-groundwater relations, *Streamflow, *Suspended sediments, *Colorado, *Irrigation canals, Fort Morgan, South Platte River, Sediment transport, Silt, Clay, Particle size, Stream discharge, Beaver Canal, Fort Morgan Canal, Rivers.

A 2-year study during 1982-83 was made to document the streamflow gain-and-loss and suspended sediment characteristics of the South Platte River, Fort Morgan Canal, Upper Platte and Beaver Canal, and the Lower Platte and Beaver Canal near Fort Morgan, Colorado, prior to possible construction of the proposed Narrows Reservoir. Six streamflow gain-and-loss investigations, conducted in 1982 along a 25.8 mi reach of the South Platte River, indicate an average downstream gain in discharge of 150 cu ft/sec during the irrigation season. The Fort Morgan Canal and the Lower Platte and Beaver Canal had decreasing discharges in the downstream direction. The Upper Platte and Beaver Canal had a slight increased in discharge at the second measurement site and decreases in the third and fourth measurement sites. Irrigation practices and some loss to the groundwater system account for the general decrease in discharge. Suspended sediment data were collected at the streamflow-gaging station 06758500 South Platte River near Weldona and on the three irrigation canals: Fort Morgan Canal, Upper Platte and Beaver Canal, and Lower Platte and Beaver Canal. The data indicate that relations exist between the suspended sediment concentrations at the South Platte River station and the suspended sediment concentrations at the most upstream measurement site on each canal. Relations between suspended sediment discharge and water discharge were developed at all canal measurement sites. For all the canals, suspended sediment discharge decreased in a downstream direction. Slight increases in suspended sediment occurred at the second measurement site on the Upper Platte and Beaver Canal and at the third measurement site on the Lower Platte and Beaver Canal. Laboratory analyses indicate that 75% of the suspended sediment is silt and clay size (particles finer than 0.062 mm). (Author's abstract)
W89-06865

IMPACT OF THE PROPOSED I-326 CROSSING ON THE 500-YEAR FLOOD STAGES OF THE CONGAREE RIVER, NEAR COLUMBIA, SOUTH CAROLINA,
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-06872

STATISTICAL SUMMARIES OF STREAMFLOW RECORDS IN OKLAHOMA AND PARTS OF ARKANSAS, KANSAS, MISSOURI, AND TEXAS THROUGH 1984,
Geological Survey, Oklahoma City, OK. Water Resources Div.
D. C. Heimann, and R. L. Tortorelli.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4205, 1988. 387p, 180 fig, 180 tab, 15 ref.

Descriptors: *High flow, *Low flow, *Flood peak, *Flow duration, *Streamflow, *Statistics, *Oklahoma, Frequency analysis, Regulated flow, Natural flow, Hydrographs, Maximum flow, Minimum flow, Statistical analysis, Arkansas, Kansas, Missouri, Texas.

Statistical summaries of streamflow at 148 gaging stations are presented. Summaries are given for both unregulated and regulated streamflow records when at least 10 years of unregulated or regulated data are available. Streamflow records for 70 of the 148 stations include regulated periods and data for these periods were analyzed separately to account for changes in streamflow due to regulating structure. For each gaging station, a brief description of the location, period record, and drainage area is given. For these stations with regulated streamflow, a brief regulation history is also given. This information is followed by tables of monthly and annual flow statistics, low- and high-flow frequency statistics, peak-flow frequency statistics, and flow-duration statistics. Daily flow-duration hydrographs are included for most stations. (USGS)
W89-06885

FLOOD HYDROLOGY NEAR FLAGSTAFF, ARIZONA,
Geological Survey, Flagstaff, AZ. Water Resources Div.
For primary bibliographic entry see Field 2A.
W89-06886

BUOYANCY INDUCED PLUNGING FLOW INTO RESERVOIRS AND COASTAL REGIONS,
Minnesota Univ., Minneapolis. Graduate School.
G. J. Farrell.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8620154. Ph.D. Dissertation, 1986. 278p, 104 fig, 31 tab, 86 ref, 2 append.

Descriptors: *Density currents, *Water circulation, *Turbidity, *Reservoirs, *Plunging flow, Flow discharge, Flow rates, Laminar flow, Turbulent flow, Simulation analysis, Model studies, Flow Separation, Numerical analysis.

Plunging reservoir flow was simulated by extracting numerical solutions to the governing equations of flow and studied experimentally by reproducing the phenomenon in a laboratory model reservoir. A laminar flow model is shown to have serious limitations. Turbulent flow is simulated using a model with an energy draining buoyancy term in the k equation. This simulation provides useful insight into the development, growth, and decay of a plunging flow field. A relation is proposed for estimating initial mixing in sloping bottom reservoirs. Data on initial mixing in the sloping bottom case experimentally confirm the numerically generated relationship. Sidewall flow separation was the dominant phenomenon in the diverging reservoir experiments. Initial mixing in the diverging reservoir was very high because of the flow separation effects. (Cremmins-AEPCO)
W89-06947

2F. Groundwater

DESIGN AND USE OF A HYDRAULIC POTENTIOMANOMETER FOR DIRECT MEASUREMENT OF DIFFERENCES IN HYDRAULIC HEAD BETWEEN GROUNDWATER AND SURFACE WATER,
Geological Survey, Lakewood, CO.
For primary bibliographic entry see Field 7B.
W89-05808

RISK ANALYSIS OF AQUIFER CONTAMINATION BY BRINE,
Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
B. F. Hobbs, C. V. Patterson, M. E. Maciejowski, and Y. Y. Haimes.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 667-685, November 1988. 4 fig, 4 tab, 27 ref, 2 append.

Descriptors: *Risk assessment, *Aquifers, *Underground waste disposal, *Path of pollutants, *Groundwater pollution, *Brines, Ohio, Risks, Water quality, Evaluation, Groundwater management, Water pollution prevention, Decision making, Path of pollutants, Leaching, Public health, Model studies, Wastewater disposal.

Underground disposal of liquid wastes poses a danger of groundwater contamination. The prediction of their impacts is subject to many uncertainties. A risk analysis model is developed that addresses several of these uncertainties. The model inputs are hydrogeologic parameters, the reliability of waste disposal, and demographic information. The outputs of the model are probability distributions of the number of rural home wells or municipal groundwater well fields that may be contaminated. Contamination is defined as occurring when the concentration for any disposed chemical exceeds its water quality standard. The model is used to analyze the risks posed by annular disposal of oil and gas brines in Ohio. It is found that the economic costs associated with those risks are an order of magnitude smaller than the benefits of the practice. (Author's abstract)
W89-05820

IMPLICATIONS OF SEA-LEVEL RISE ON THE SOUTH SHORE OF LONG ISLAND, NEW YORK,
Maryland Univ., College Park. Dept. of Geography.
For primary bibliographic entry see Field 2L.
W89-05833

HACHIOJI EXPERIMENTAL BASIN STUDY: STORM RUNOFF PROCESSES AND THE MECHANISM OF ITS GENERATION,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2E.
W89-05847

SOME EXPERIMENTAL RESULTS CONCERNING RAPID WATER TABLE RESPONSE TO SURFACE PHENOMENA,
Tsukuba Univ. (Japan). Inst. of Geoscience.
I. Kayane, and I. Kaihotsu.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 215-234, September 30, 1988. 16 fig, 19 ref.

Descriptors: *Infiltration, *Rainfall-runoff relationships, *Water table fluctuations, *Soil water, *Surface-groundwater relations, *Aerated zone, Wave propagation, Hydraulic models, Artificial soils, Capillary waves, Capillary water, Experimental design, Rainfall.

Transient phenomena relating to flow in the vadose zone are reviewed, including rapid water table response to rainfall, pulsating flow due to pressure perturbations in the vadose zone, and the

wave-like propagation of increased soil moisture caused by intermittent rainfall. As a basis for interpreting these phenomena, dividing the vadose zone into a residual water zone, an unsaturated capillary zone, and a saturated capillary zone (SCZ) is proposed. Since the SCZ is quasi-saturated even though the pressure is negative, if the SCZ extends from the water table to ground surface, the addition of a small amount of water to the surface can change the pressure from negative to positive. The rapid apparent rise and fall of the water table after heavy rainfall or irrigation occur by the buildup of a pneumatic potential due to the infiltrating water. The results suggests that a rapid runoff composed of pre-event water from a drainage basin should be expected as a response to a storm event. (Rochester-PTT)
W89-05851

ANALYSIS OF THREE-DIMENSIONAL GROUNDWATER FLOW IN THE NEAR-SURFACE LAYER OF A SMALL WATERSHED,
Saitama Univ., Urawa (Japan). Hydroscience and Geotechnology Lab.
K. Watanabe.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 287-300, September 30, 1988. 18 fig, 2 tab, 9 ref.

Descriptors: *Model studies, *Infiltration *Soil water movement, *Subsurface drainage, *Groundwater movement, *Topography, *Rainfall-runoff relationships, *Hydrologic models, *Surface-groundwater relations, Mathematical models, Geographic models, Experimental basins, Finite element method, Japan, Geohydrology, Catchment areas.

A computer model for the calculation of three-dimensional groundwater flow through a highly permeable near-surface layer is presented with the aim of analyzing the runoff in a small watershed. Groundwater flow under both saturated and unsaturated conditions was calculated by a finite-element method. The program is based on a geographical model of a watershed that is defined by 17 geometric parameters. A watershed of any shape can be adapted easily by inputting these 17 parameters. The near-surface layer of the watershed is automatically divided into 56 hexahedral elements and the location of each nodal point for the calculation is determined by the computer. Transient behavior of groundwater flow and runoff phenomena in response to an intense rain of short duration observed in the Inuyama Test Basin (Japan) was studied using the model. Although some approximations of the hydrogeological parameters were necessary, the general tendency of the groundwater flow in the near-surface layer of the watershed was analyzed successfully. (Author's abstract)
W89-05855

INCORPORATION OF THE EFFECT OF CONCENTRATION OF FLOW INTO THE KINEMATIC WAVE EQUATIONS AND ITS APPLICATIONS TO RUNOFF SYSTEM LUMPING,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05856

SOIL-AQUIFER-STREAM INTERACTIONS: A REDUCTIONIST ATTEMPT TOWARD PHYSICAL-STOCHASTIC INTEGRATION,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-05859

PREDICTION BY THE METHOD OF MOMENTS OF TRANSPORT IN A HETEROGENEOUS FORMATION,
Stanford Univ., CA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05863

USE OF VARIABLE-SCALE PRESSURE TEST DATA TO ESTIMATE THE LOG HYDRAULIC CONDUCTIVITY COVARIANCE AND DISPERSIVITY OF FRACTURED GRANITES NEAR ORACLE, ARIZONA,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. P. Neuman, and J. S. Depner.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 475-501, September 30, 1988. 11 fig, 7 tab, 25 ref, 3 append. Nuclear Regulatory Commission Contract NRC-04-78-275.

Descriptors: *Groundwater movement, *Aquifer testing, *Pumping tests, *Packer tests, *Stochastic process, *Hydraulic conductivity, *Geologic fractures, *Anisotropy, *Pressure tests, *Dispersivity, Estimating, Nonuniform media, Spatial variation, Theoretical analysis, Statistics, Covariance, Oracle, Arizona.

Application of modern stochastic theories to nonuniform geologic media requires, among other things, knowing the principal directions and correlation lengths of the log hydraulic conductivity covariance. To infer this information by standard geostatistical methods directly from point measurements of hydraulic conductivity in three-dimensional space is seldom possible due to scarcity of data. To show how this difficulty can be overcome, the example of fractured granitic rocks near Oracle, Arizona is used. At this site, hydraulic conductivities were measured on a small scale by packer tests and on a larger scale by cross-hole test. The test results suggest that the measured hydraulic conductivities can be viewed as quantities defined over a continuum that are scalar on a local scale but exhibit large scale anisotropy due to spatial nonuniformity and the effect of fracture orientations. Based on this observation, the two sets of hydraulic conductivity data are related theoretically and the resulting expression used to estimated the anisotropic covariance function of log hydraulic conductivities at the Oracle site. These parameters were used to calculate a Fickian dispersivity tensor for the Oracle granite by relying on the recently advanced theory of Neuman and coworkers. The results highlight the need to extend available stochastic theories to the domain of strongly nonuniform media, the properties of which fluctuate with large amplitudes. (Author's abstract)
W89-05864

LIFETIME PROBABILITY DENSITY FUNCTION FOR SOLUTE MOVEMENT IN THE SUBSURFACE ZONE,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-05865

FLOW OF GROUND WATER TO A WELL NEAR A STREAM: EFFECT OF AMBIENT GROUND-WATER FLOW DIRECTION,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
J. M. Newsom, and J. L. Wilson.
Ground Water GRWAAR, Vol. 26, No. 6, p 703-711, November-December 1988. 8 fig, 11 ref.

Descriptors: *Surface-groundwater relations, *Groundwater movement, *Well intake, *Streams, *Aquifers, *Pump wells, Capture zone, Groundwater pollution, Groundwater management, Mathematical models, Infiltration, Geochemistry, Future planning, Flow nets, New Mexico, Induced infiltration.

An analytical model has been developed to evaluate and improve knowledge of steady-state flow of groundwater toward a well near a stream. This model differs from others in that the direction of ambient groundwater flow (i.e., regional groundwater flow) does not have to be perpendicular to a gaining stream, but can be oriented in any direction. Without using measured water levels, flow directions and rates can be calculated, i.e., estimated flow nets can be drawn based on the pumping rate, the ambient groundwater flow rate and direction, and the location of the well and stream. The model can be used to help determine the minimum rate of pumping that will induce infiltration from a stream to a well, and the components of pumping that are derived from the stream and the aquifer. The areal distribution of flow includes a zone of induced infiltration from a stream toward a pumping well denoted the stream capture zone, a zone that includes all ambient groundwater captured by a pumping well called the aquifer capture zone, and a zone downstream of the stream capture zone where water flows from the stream into the aquifer and then back to the gaining stream called the zone of induced throughflow. Each zone could be distinct geochemically. The concepts elucidated by the model are useful for groundwater pollution studies and for planning purposes. Normalized curves are presented to quickly determine the estimated boundaries between the stream capture zone and the zone of induced throughflow. An example of induced streamflow from Albuquerque, New Mexico illustrates application of the model. (Author's abstract)
W89-05873

CONDUCTIVITY VARIATIONS OF FORMATION WATERS IN COASTAL ALLUVIUM, ANDHRA PRADESH, INDIA,
Andhra Univ., Waltair (India). Dept. of Geophysics.
C. Subbarao, and C. Satyanarayana.
Ground Water GRWAAR, Vol. 26, No. 6, p 712-716, November-December 1988. 3 fig, 3 tab, 7 ref.

Descriptors: *Coastal aquifers, *India, *Water quality, *Saline water-freshwater interfaces, *Conductivity, *Alluvial deposits, Formation waters, Chlorides, Wells, Groundwater.

Groundwater samples collected from wells in the coastal alluvial sediments of Andhra Pradesh near the Bay of Bengal have a large variation in conductivity values that can be related to chloride concentration and soil influence. In addition to spatial variation, there appears to be a relationship between the depth to groundwater level and conductivity of formation water. Wells with water levels above 3 m have a greater range of conductivity than those with water levels below 3 m. (Author's abstract)
W89-05874

GROUND-WATER FLOW MODEL OF DRAWDOWN AND RECOVERY NEAR AN UNDERGROUND MINE,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
L. Toran, and K. R. Bradbury.
Ground Water GRWAAR, Vol. 26, No. 6, p 724-733, November-December 1988. 7 fig, 2 tab, 27 ref.

Descriptors: *Mine drainage, *Groundwater movement, *Hydrologic models, *Model studies, *Underground mining, *Drawdown, Groundwater pollution, Sulfates, Aquifers, Recovery, Wisconsin, Computer programs, Model testing, Hydrological data collections, Depression head, Calibration.

The U.S. Geological Survey's modular code was used to reconstruct past groundwater flow paths and make predictions of future flow patterns to understand movement of sulfate-contaminated groundwater through a carbonate aquifer near an underground mine. The abandoned mine is in the zinc-lead district near the town of Shullsburg in southwestern Wisconsin and operated from the 1920s until 1979. The model was calibrated with historic data (1954, 1955, 1957, and 1958) and new measurements (1983). The model predicts observed hydraulic head distributions and groundwater discharge rates with fair accuracy. Instantaneous dewatering rates are underestimated, but long-term rates can be estimated with the model. The persistence of a cone of depression at present and in the future allows uncontaminated water from surrounding areas to dilute the sulfate, as confirmed by chemical sampling. The model predicts radial flow will persist near the Shullsburg mines until approximately 1988. The model represents a significant test of the ability of a groundwater flow model to predict the impacts of underground mining on groundwater systems. The method used required field data collected before, during, and after mining. A model calibrated to just one or two

of these data sets is likely to have larger associated uncertainties. (Author's abstract)
W89-05876

SEMIANALYTICAL COMPUTATION OF PATH LINES FOR FINITE-DIFFERENCE MODELS,
Geological Survey, Reston, VA. Water Resources Div.
D. W. Pollock.
Ground Water GRWAAR, Vol. 26, No. 6, p 743-750, November-December 1988. 11 fig, 8 ref.

Descriptors: *Flow pattern, *Model studies, *Groundwater movement, *Mathematical models, *Finite difference methods, Path line computation, Flow velocity, Mathematical equations, Travel time.

A semianalytical particle tracking method was developed for use with velocities generated from block-centered finite-difference groundwater flow models. The method is based on the assumption that each directional velocity component varies linearly within a grid cell in its own coordinate directions. This assumption allows an analytical expression to be obtained describing the flow path within an individual grid cell. Given the initial position of a particle anywhere in a cell, the coordinates of any other point along its path line within the cell and the time of travel between them, can be computed directly. For steady-state systems, the exit point for a particle entering a cell at any arbitrary location can be computed in a single step. By following the particle as it moves from cell to cell, this method can be used to trace the path of a particle through any multidimensional flow field generated from a block-centered finite-difference flow model. (Author's abstract)
W89-05878

TESTING A LIMESTONE AQUIFER USING WATER-TABLE RESPONSE TO STORM WATER DISCHARGED INTO SINKHOLES,
TRC Environmental Consultants, Inc., Somerset, NJ.
A. Michalski, and J. Torlucci.
Ground Water GRWAAR, Vol. 26, No. 6, p 751-760, November-December 1988. 9 fig, 2 tab, 19 ref.

Descriptors: *Aquifer testing, *Monitoring, *Network design, *Pumping tests, *Water table, *Storm water, *Sinks, *Storm runoff, *Limestone, *Karst hydrology, Groundwater movement, Puerto Rico, Observation wells, Aquifer Characteristics, Injection, Pumping tests.

The character and performance of karstified aquifers are often difficult to assess, casting some doubt as to the monitorability of waste management facilities located in karstic settings. In the case of a Puerto Rican aquifer, analysis of water-table response to storm water discharged to sinkholes allowed characterization of the flow type in the aquifer, estimation of aquifer parameters, and aided in assessing the monitorability of the site. Water-level data from observation wells have indicated that storm water discharged into on-site sinkholes produced fairly regular mounding patterns in the aquifer. Such patterns suggested an isotropic character and predominantly diffuse groundwater transmission within the aquifer. An injection well analogy was used for storm-water discharge at the sinkholes to analyze the water-level data and estimate values of aquifer parameters. Analysis of transient water levels in response to natural stresses can provide a useful tool of hydrogeologic exploration at sites where sinkholes act as strong and variable point sources. At such sites, traditional well pumping/injection tests may be subject to erroneous interpretations. (Author's abstract)
W89-05879

TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA-WATER INTRUSION IN MONTEREY COUNTY, CALIFORNIA.
Monterey County Food Control and Water Conservation District, Salinas, CA.
For primary bibliographic entry see Field 7B.
W89-05881

FIELD APPLICATION OF A NUMERICAL METHOD FOR THE DERIVATION OF BASE-FLOW RECESSION CONSTANT,
Loughborough Univ. of Technology (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-05888

REVIEW OF CHEMICAL SOLUTE TRANSPORT MODELS,
Technical Univ. of Denmark, Lyngby.
For primary bibliographic entry see Field 5B.
W89-05902

ENGINEERING AND ENVIRONMENTAL GEOLOGY OF THE INDIAN WELLS VALLEY AREA, SOUTHEASTERN CALIFORNIA,
Naval Weapons Center, China Lake, CA.
For primary bibliographic entry see Field 4C.
W89-05911

SELENATE TRANSPORT IN STEADY-STATE, WATER-SATURATED SOIL COLUMNS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W89-05932

MIGRATION OF TECHNETIUM, IODINE, NEPTUNIUM, AND URANIUM IN THE PEAT OF TWO MINEROTROPHIC MIRES,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Environmental Research Branch.
For primary bibliographic entry see Field 5B.
W89-05936

CASE STUDY OF THE EFFECTS OF OIL SHALE OPERATIONS ON SURFACE AND GROUNDWATER QUALITY: I. SOURCES OF CONTAMINATION AND HYDROLOGIC CONTROLS ON WATER COMPOSITION,
Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
For primary bibliographic entry see Field 5B.
W89-05937

CASE STUDY OF THE EFFECTS OF OIL SHALE OPERATIONS ON SURFACE AND GROUNDWATER QUALITY: II. MAJOR INORGANIC IONS,
Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
For primary bibliographic entry see Field 5B.
W89-05938

EXAMINATION OF 2-D GROUNDWATER RECHARGE SOLUTION,
Louisiana Tech Univ., Ruston. Dept. of Civil Engineering.
D. M. Griffin, and R. O. Warrington.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 691-704, November 1988. 10 fig, 1 tab, 9 ref.

Descriptors: *Mathematical studies, *Infiltration, *Recharge, *Model studies, *Groundwater recharge, Groundwater management, Prediction, Aquifers, Aquifer characteristics.

The analytical solution proposed by Rao and Sarma for predicting growth of groundwater mounds resulting from infiltration into bounded aquifers is examined for validity when the aquifer is assumed infinite in size. Rao and Sarma concluded that an aquifer can be assumed infinite when the ratio of corresponding linear dimensions of the aquifer and infiltration surface (A/L) is made arbitrarily large; they used A/L = 50, 60, and 70. Under such conditions, mound height at the center should approach a constant value. Contrary to Rao and Sarma's conclusions, it was found that maximum mound height appears to depend on the relative size of the aquifer in a specific fashion, exhibiting a maximum value when A/L = 200. Above this value,predicted mound height gradually drops to zero. Among the solution presented here, the infinite aquifer solutions published by Hantush, and a solution for circular infiltration areas derived here, agreement is limited to the case where A/L = 200. In spite of this inconsistency, the equation proposed by Rao and Sarma may be programmed for solution without knowledge of advanced mathematical concepts. For the physical parameters used, their solution is judged to be a relatively quick and easy way to predict maximum mound height, so long as A/L is assigned a value of 200. (Author's abstract)
W89-05964

DEFINING PHREATIC SURFACE FOR HETEROGENEOUS AQUIFERS,
Baghdad Univ. (Iraq). Coll. of Engineering.
A. J. Alawi, and K. A. Rahi.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 713-716, November 1988. 3 fig, 3 ref.

Descriptors: *Free surfaces, *Water table, *Phreatic surface, *Infiltration, *Aquifers, *Groundwater movement, Flow, Mathematical studies, Heterogeneous aquifers, Porous media, Stratified flow, Heterogeneity.

Outmans' approach to computing the discharge of a free surface flow through a heterogeneous aquifer is extended and used to compute the head of vertically stratified porous media. Outmans' formula itself is an extension of Dupuit-Forchheimer's discharge formula for free surface flow which has been proven valid despite its unrealistic assumptions. The Dupuit's formula is generalized to define the phreatic surface of a flow through heterogeneous (vertically stratified) porous media. The generalization is, in effect, a transformation of the heterogeneous media to a homogeneous one. The new approach gives one equation to define the phreatic surface throughout the flow domain no matter how many layers are included in it. (Miller-PTT)
W89-05966

IRON AND MANGANESE REMOVAL FROM A GROUNDWATER SUPPLY,
Arber (Richard P.) Associates, Inc., Denver, CO.
For primary bibliographic entry see Field 5F.
W89-06009

DETERMINATION OF URANIUM IN NATURAL GROUNDWATERS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 5A.
W89-06176

PATTERNS OF GROUND-WATER CHEMISTRY, ROSS CREEK BASIN, ALBERTA, CANADA,
Alberta Univ., Edmonton. Dept. of Geology.
For primary bibliographic entry see Field 2K.
W89-06200

MULTIVARIATE ANALYSIS IN HYDROCHEMISTRY: AN EXAMPLE OF THE USE OF FACTOR AND CORRESPONDENCE ANALYSES,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2K.
W89-06201

DISSOLVED INORGANIC CARBON IN THE TUCSON BASIN AQUIFER,
Arizona Univ., Tucson. Dept. of Geosciences.
For primary bibliographic entry see Field 2K.
W89-06203

ARTIFICIAL RECHARGE IN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA,

Las Vegas Valley Water District, NV.
For primary bibliographic entry see Field 4B.
W89-06204

DETERMINATION OF AQUITARD/AQUICLUDE HYDRAULIC PROPERTIES FROM ARBITRARY WATER-LEVEL FLUCTUATIONS BY DECONVOLUTION,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
S. P. Neuman, and D. A. Gardner.
Ground Water GRWAAR, Vol. 27, No. 1, p 66-76, January-February 1989. 9 fig, 18 ref.

Descriptors: *Pumping tests, *Aquifer testing, *Aquifer characteristics, *Aquitards, *Water level fluctuations, *Deconvolution model, Hydraulic models, Model studies, Piezometers, Hydraulic conductivity, Hydraulic diffusivity, California, Oxnard Plain, Performance evaluation, Mathematical equations.

A deconvolution model is proposed for the estimation of aquitard/aquiclude vertical hydraulic diffusivities on the basis on water level measurements in piezometers completed both in the confining layer(s) and in neighboring aquifers. The water levels may fluctuate in an arbitrary manner that is not necessarily caused by a prescribed pumping regime (as required in conventional pumping tests). A simple formula from the literature can be used to correct the measured water levels for time lag in the piezometer response. If the specific storage of the confining material is known from laboratory consolidation tests, the hydraulic diffusivity estimates can be translated into vertical hydraulic conductivities. The method is illustrated with a case study from Ventura County, California (Oxnard Plain groundwater basin) and is shown to yield robust parameter estimates. (Author's abstract)
W89-06206

APPROXIMATE AND ANALYTICAL SOLUTIONS FOR SOLUTE TRANSPORT FROM AN INJECTION WELL INTO A SINGLE FRACTURE,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 5B.
W89-06207

METHOD FOR INSTALLING AND MONITORING PIEZOMETERS IN BEDS OF SURFACE WATERS,
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 7B.
W89-06208

INTERPRETATION OF FIELD TRACER TESTS OF A SINGLE FRACTURE USING A TRANSIENT SOLUTE STORAGE MODEL,
National Hydrology Research Inst., Ottawa (Ontario).
For primary bibliographic entry see Field 7B.
W89-06258

FLOW AND TRACER TRANSPORT IN A SINGLE FRACTURE: A STOCHASTIC MODEL AND ITS RELATION TO SOME FIELD OBSERVATIONS,
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 7B.
W89-06259

FLOW AND TRACER TRANSPORT IN FRACTURED MEDIA: A VARIABLE APERTURE CHANNEL MODEL AND ITS PROPERTIES,
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5B.
W89-06260

NOTE ON THE RECENT NATURAL GRADIENT TRACER TEST AT THE BORDEN SITE,
Geological Survey, Denver, CO.
For primary bibliographic entry see Field 7C.
W89-06264

EFFECTS OF GLACIAL ICE ON SUBSURFACE TEMPERATURES OF HYDROTHERMAL SYSTEMS IN YELLOWSTONE NATIONAL PARK, WYOMING: FLUID-INCLUSION EVIDENCE,
Geological Survey, Menlo Park, CA.
K. E. Bargar, and R. O. Fournier.
Geology GLGYBA, Vol. 16, No. 12, p 1077-1080, December 1988. 3 fig, 2 tab, 14 ref.

Descriptors: *Hydrothermal studies, *Thermal properties, *Glaciers, *Ice pressure, *Crystallization, *Wyoming, Core drilling, Geysers, Natural recharge, Quartz, Chemical precipitation, Pore pressure, Yellowstone National Park.

Hydrothermal quartz and fluorite crystals containing liquid-rich fluid inclusions were found in drill cores from eight relatively-shallow research holes drilled by the U.S. Geological Survey in and near major geyser basins of Yellowstone National Park. Homogenization temperatures (HTs) for mostly secondary fluid inclusions show variations in temperature that have occurred at given depth since precipitation of the host minerals. Within major hydrothermal upflow zones, fluid-inclusion HT values all were found to be equal to or higher (commonly 20-50 C and up to 155 C higher) than present temperatures at the depths sampled. During periods when thick glacial ice covered the Yellowstone National Park region, pore-fluid pressures in the underlying rock were increased in proportion to the weight of the overlying column of ice. Accordingly, theoretical reference boiling-point curves that reflect the maximum temperature attainable in a hot-water geothermal system at a given depth were elevated, and temperatures within zones of major hydrothermal upflow increased. At the margins of major hydrothermal upflow zones, fluid-inclusion HT values at given depths range from 57 C lower to about the same as the current temperature measurements because of a previous decrease in the rate of discharge of warm water and/or an increase in the rate of recharge of cold water into the hydrothermal system. (Author's abstract)
W89-06291

HYDROLOGY OF LAKE AMADEUS, A GROUNDWATER-DISCHARGE PLAYA IN CENTRAL AUSTRALIA,
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
G. Jacobson.
BMR Journal of Australian Geology and Geophysics BJAGDT, Vol. 10, No. 4, p 301-308, June 1988. 11 fig, 1 tab, 11 ref.

Descriptors: *Playas, *Hydrology, *Arid-zone hydrology, *Australia, *Groundwater runoff, *Geohydrology, Evaporation discharge, Salt flats, Brines, Gypsum.

Lake Amadeus, a large playa in central Australia, is part of a 500 km long groundwater discharge zone, which extends from Lake Hopkins, in Western Australia, to the Finke River. In this zone, groundwater discharges and evaporates at playa surfaces over a total area of 1750 sq km. Groundwater flows towards Lake Amadeus in Cainozoic sediments which overlie fractured Proterozoic bedrock. Sediments beneath the lake bed are saturated with sodium-magnesium chloride rich brine, which contains about 250 g/L total dissolved solids. The lake bed is generally dry and contains areas of heaved gypsum ground and slightly lower, flat, halite-encrusted zones which are occasionally flooded. Gypsum is actively precipitating in the capillary zone above the water-table, which is generally at a depth of 0.30-0.50 m. In Lake Amadeus and other nearby playas the total mass of salt stored is estimated as about 6 billion tons and this has accumulated in about 12,000 years. Water-budget calculations show that groundwater recharge in the catchment of 90,000 sq km is approximately 1 mm/year, which is only 0.4% of the incident rainfall. (Author's abstract)
W89-06327

ORIGIN AND GENESIS OF PHOSPHATE CONTENT IN THE MINERAL SPRINGS OF PECHBRUNN/OBERPFALZ,
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
For primary bibliographic entry see Field 2K.
W89-06420

APPROACHES TO RAPID AND FAR-REACHING HYDROLOGIC PROCESSES IN THE VADOSE ZONE,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Soils and Crops.
P. F. Germann.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 115-127, December 1988. 2 fig, 1 tab, 57 ref. EPA project CR813575-01-0.

Descriptors: *Path of pollutants, *Groundwater movement, *Soil water, *Vadose water, *Porous media, *Solute transport, Flow, Convection, Dispersion, Porosity.

Flow and transport in porous media are conventionally approached by averaging convective-dispersive approaches. The applicability of potential flow theory to porous media is based mainly on two assumed conditions: (1) the significant properties, such as water content, water potentials, potential gradient, and hydraulic conductivity, are continuously defined in the entire macroscopic flow region, regardless of the actual nature of the microscopic environment; (2) the dispersion of potential energy and water occurs at the same rate during transient flow. Many expressions have been introduced to describe deviations from the applied convective-dispersive approaches to water flow and transport of solutes and particles in the vadose zone. Some of then are more process related, such as the concept of mobile/immobile water, preferred flow, and bypass flow. Others are more oriented toward presumably related morphological features of the vadose zone, such as macropore flow, fissure flow, flow in biopores, and preferential flow paths. A framework is introduced in which further discussions can be arranged on the topic of rapid and far-reaching hydrologic processes in the vadose zone. (Sand-PTT)
W89-06421

WETTING FRONT INSTABILITY AS A RAPID AND FAR-REACHING HYDROLOGIC PROCESS IN THE VADOSE ZONE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W89-06426

PRELIMINARY CAPILLARY HYSTERESIS SIMULATIONS IN FRACTURED ROCKS, YUCCA MOUNTAIN, NEVADA,
Lawrence Berkeley Lab., CA. Earth Sciences Div.
A. Niemi, and G. S. Bodvarsson.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 277-291, December 1988. 7 fig, 1 tab, 23 ref. U.S. DOE contract No. DEAC03-76SF00098.

Descriptors: *Rocks, *Geologic fractures, *Hysteresis, *Capillarity, *Capillary water, *Path of pollutants, *Radioactive waste disposal, *Geohydrology, *Soil water, Yucca Mountains, Nevada, Hygroscopic water, Simulation.

Preliminary simulations were carried out to address the question of how hysteretic (history-dependent) capillary pressure-liquid saturation relation may affect the flow and liquid saturation distribution in a fractured rock system. Using a hysteresis model modified from the theoretically based dependent domain model of Mualem, a system consisting of discrete fractures and rock matrix parts was simulated under periodically occurring infiltration pulses. Comparisons were made between the hysteretic case and the non-hysteretic case using the main drying curve alone. Material properties used represent values reported for the

densely welded tuffs at Yucca Mountain, Nevada. Since no actual hysteresis measurements were available for the welded tuffs, the necessary data was derived based on information available in the soils literature. The strongly hysteretic behavior in the uppermost layer of the matrix, along with the overall lower matrix capillary suctions, generated higher fracture flows and a more 'smeared' matrix liquid saturation vs. depth distribution for the hysteretic case. While the actual amounts of water being absorbed into the matrix were very similar, the distributions of this absorbed water were different and the matrix was affected up to greater depths in the hysteretic case in comparison to the non-hysteretic case. (Author's abstract)
W89-06430

PRELIMINARY OBSERVATIONS OF STREAMFLOW GENERATION DURING STORMS IN A FORESTED PIEDMONT WATERSHED USING TEMPERATURE AS A TRACER,
Geological Survey, Doraville, GA.
For primary bibliographic entry see Field 2A.
W89-06434

RAPID FLOW THROUGH THE SEDIMENTS OF A HEADWATER STREAM IN THE SOUTHERN APPALACHIANS,
Georgia Univ., Athens. Inst. of Ecology.
For primary bibliographic entry see Field 2E.
W89-06448

FLOW REGIME ASSOCIATED WITH PARTIALLY PENETRATING LARGE-DIAMETER WELLS IN HARD ROCKS,
National Geophysical Research Inst., Hyderabad (India).
C. P. Gupta, and V. S. Singh.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 209-217, November 30, 1989. 6 fig, 2 tab, 6 ref.

Descriptors: *Vertical flow, *Aquifers, *Models, *Wells, *Pumping tests, *Groundwater movement, Granites, Pump wells, Finite difference methods, Case studies, Permeability, Geohydrology.

In the case of a large-diameter well which penetrates an aquifer only partially, significant vertical flows may set in as a result of withdrawal from the well provided that the vertical permeability below the well bottom is appreciable. A finite difference model of groundwater flow regime associated with a partially penetrating well in hard rock terrain (granitic) is presented. Use of this model in the estimation of hydrogeological parameters in such a situation is illustrated by a field example. The analysis of pump test data shows that parameter estimation will be in error if the vertical flows are neglected. The upward flow gradually reduces as one moves away from the pumping well and finally the flow direction is reversed. The magnitude of the upward flow increases with time as pumping progresses. Once the hydrogeological parameters are identified, the same model can be used to predict drawdowns in the aquifer at any radial distance from the well for different rates of pumping. The same model has also been used for prognosing the efficacy of a borewell in a large-diameter partially penetrating well to increase the yield. (Author's abstract)
W89-06455

ANALYSIS OF PUMP TEST DATA FOR A LARGE-DIAMETER WELL NEAR A HYDROGEOLOGICAL BOUNDARY,
National Geophysical Research Inst., Hyderabad (India).
V. S. Singh, and C. P. Gupta.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 219-227, November 30, 1988. 4 fig, 1 tab, 7 ref, 2 append.

Descriptors: *Wells, *Geohydrologic boundaries, *Pumping tests, *Numerical analysis, *Groundwater movement, *Boundary conditions, Computer models, Aquifers, Pump wells, India, Computer programs.

A numerical method is presented for the interpretation of pump test data for a large-diameter well situated near such a boundary as a river, a lake or a dike which commonly occur in hard rock terrains. The technique considers the time-drawdown data for the pumping as well as for the recovery phase. A field example is presented to illustrate the use of the technique on a large-diameter well in a granitic terrain of Southern India where surface reservoirs are very common to support the farming during nonrainy seasons and also to keep neighboring wells running. The computer code for numerical modeling is given in BASIC language which can easily be implemented on a portable microcomputer for the estimation of aquifer parameters in the field. (Author's abstract)
W89-06456

FINITE ELEMENT MODEL OF NITROGEN SPECIES TRANSFORMATION AND TRANSPORT IN THE UNSATURATED ZONE,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 5B.
W89-06458

ADDITIONAL SOLUTIONS FOR STEADY-STATE EVAPORATION FROM A SHALLOW WATER TABLE,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 2D.
W89-06481

TRITIUM AND HELIUM ISOTOPES AS HYDROLOGIC TRACERS IN A SHALLOW UNCONFINED AQUIFER,
Scripps Institution of Oceanography, La Jolla, CA.
For primary bibliographic entry see Field 7B.
W89-06508

TWO-DIMENSIONAL FINITE ELEMENT MODEL FOR DISPERSION (2D-FED) IN COASTAL AQUIFERS,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
M. M. Sherif, V. P. Singh, and A. M. Amer.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 11-36, November 15, 1988. 8 fig, 29 ref, append.

Descriptors: *Model studies, *Saline water intrusion, *Coastal aquifers, Simulation, Aquifers, Confined aquifers, Leaky aquifers, Differential equations, Piezometric head, Anisotropy, Nile Delta, Velocity.

A two-dimensional finite element model was developed to simulate the saltwater intrusion phenomena in confined and leaky coastal aquifers under steady state conditions. The governing equations are combined into two nonlinear coupled partial differential equations in only two variables, namely, the concentration and the equivalent freshwater piezometric head. The Galerkin technique is employed, with the computation scheme based on the relaxation method. Heterogeneity and anisotropy of the aquifer are considered. The dispersion coefficient is taken to be velocity dependent. The model was in close agreement with the Rouve model for the prediction of equiconcentration lines in the coastal aquifer near Madras coast. The agreement for the hypothetical case with the Kawatani model is also satisfactory. Discrepancies between the two solutions are expected, because Kawatani took independent dispersion coefficients to avoid instability problems. The model also simulates the saltwater intrusion phenomena in the Nile Delta aquifer in Egypt. Isochlore line 35.0, which represents the seawater, intruded inland to 65.0 km from the sea boundary measured at the bottom of the aquifer. The Nile Delta aquifer is distinguished by strong cyclic flow at the sea boundary. (Doria-PTT)
W89-06509

LOGNORMAL KRIGING FOR THE ASSESSMENT OF RELIABILITY IN GROUNDWATER QUALITY CONTROL OBSERVATION NETWORKS,
Universidad Politecnica de Cataluna, Barcelona (Spain).
For primary bibliographic entry see Field 7A.
W89-06512

GEOSTATISTICAL SCHEMES FOR GROUNDWATER SAMPLING,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 7A.
W89-06513

APPLICATION OF GEOPHYSICAL METHODS IN DESCRIBING SPATIAL VARIABILITY OF SATURATED HYDRAULIC CONDUCTIVITY IN THE ZONE OF AERATION,
Geofyzika, n.p., Brno (Czechoslovakia).
O. Mazac, M. Cislerova, and T. Vogel.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 117-126, November 15, 1988. 8 fig, 2 tab, 4 ref.

Descriptors: *Soil water, *Groundwater movement, *Groundwater data, *Geophysics, *Hydraulic conductivity, *Aeration zone, *Magnetic studies, *Electrical studies, Soil properties, Spatial distribution, Soil profiles, Soil types, Permeameters, Ponding, Infiltration, Statistical analysis, Estimating, Multivariate analysis, Tectonics, Recharge.

An attempt was made to apply surface geophysical methods for the determination of spatial variability of saturated hydraulic conductivities. Methods of vertical electrical sounding and dipole electromagnetic profiling were tested in an area of 100 x 100 m. Measurements were taken on a square grid 20 by 20 m. The soil profile, formed by coarse acid brown soil of relatively high permeability underlain by a weathered gneiss substratum, is represented by four geoelectrical layers. The saturated hydraulic conductivities of both individual soil layers and the integral soil medium were compared with the geophysical parameters. They were estimated by a laboratory constant head permeameter and in the field by ponding infiltration measurements. The hydraulic conductivities of the individual soil layers were statistically derived from the resistivities of the layers, while the estimation of the conductivities of the integral soil medium generally needed some multivariate treatment of the geoelectrical data. It was concluded that the geoelectrical methods may be effectively applied to determine the spatial variation pattern of both individual and integral saturated hydraulic conductivities in the field, to estimate their relations to the deeper structural and tectonic phenomena, and to differentiate soil layers according to their properties. (Author's abstract)
W89-06515

NEW EQUATIONS OF THE SPREADING OF A TRACER IN GROUNDWATER (NOUVELLES EQUATIONS DE PROPAGATION D'UN POLLUANT DANS UNE NAPPE SOUTERRAINE),
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Geologie Appliquee.
For primary bibliographic entry see Field 5B.
W89-06519

COMMON PROPERTY AQUIFER AS A DIFFERENTIAL GAME,
Economic Research Service, Washington, DC. Resources and Technology Div.
For primary bibliographic entry see Field 4B.
W89-06575

UNSATURATED SEEPAGE AND SUBTERRANEAN HOLES: CONSPECTUS, AND EXCLUSION PROBLEM FOR CIRCULAR CYLINDRICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. R. Philip, J. H. Knight, and R. T. Waechter.
Water Resources Research WRERAO, Vol. 25, No. 1, p 16-28, January 1989. 4 fig, 2 tab, 32 ref.

Descriptors: *Soil water, *Groundwater movement, *Infiltration, *Seepage, *Deep seepage, *Unsaturated flow, *Hydrodynamics, Groundwater barriers, Underground waste disposal, Shape, Caves, Mathematical models.

The general theory of water exclusion from, or entry into, subterranean holes from steady uniform downward unsaturated seepage is discussed. Buried holes serve as obstacles to the flow and so increase water pressure at parts of the hole surface. When downward seepage is fast enough and/or the hole is large enough, water pressure increases to the point where a seepage surface forms and water enters the hole. Contrary to the conventional picture drawn from capillary statics, hydrodynamics shows that the larger the hole, the more vulnerable it is to water entry. Cavity shape is important also. Applications include optimal design of configurations of tunnels and underground repositories (e.g., for nuclear wastes) against entry of seepage water. The theory also embraces the disturbance of seepage flows by buried impermeable obstacles such as stones and structures. The quasi-linear exclusion problem for circular cylindrical cavities was solved. Both exact solutions and simple asymptotic results were found, and graphs and tables presented. The moisture field about the cavity exhibits upstream and downstream stagnation points and retarded regions: 'roof-drip lobes' in which the moisture content and downward flow velocity are augmented by water essentially deflected from the cavity roof, and the 'dry shadow' region of reduced moisture content and flow velocity, essentially sheltered by the cavity. A practical consequence is that we can establish, for any given combination of downward seepage velocity, cavity radius, saturated hydraulic conductivity K sub 1, and sorptive number alpha, whether or not seepage water will enter a cylindrical cavity. (See also W89-06577) (Author's abstract)
W89-06576

SEEPAGE EXCLUSION PROBLEM FOR SPHERICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. H. Knight, J. R. Philip, and R. T. Waechter.
Water Resources Research WRERAO, Vol. 25, No. 1, p 29-37, January 1989. 4 fig, 2 tab, 12 ref.

Descriptors: *Soil water, *Groundwater movement, *Infiltration, *Seepage, *Deep seepage, *Unsaturated flow, *Hydrodynamics, Groundwater barriers, Shape, Caves, Mathematical studies, Mathematical models.

The quasi-linear problem of water exclusion from, or entry into, spherical cavities from steady uniform downward unsaturated seepage was solved. Both exact solutions and simple asymptotic results were found. These are qualitatively similar to those given previously for circular cylindrical cavities, exhibiting such features as the dry shadow and the roof-drip lobes. A major practical result of the analysis is the function theta max(s), the dependence of the maximum potential (at the roof apex) on the dimensionless quantity s = 0.5 the sorptive number times the cavity radius; theta max(s) is almost indistinguishable from theta max(0.5s) for circular-cylindrical cavities. This implies that physically the most relevant configuration parameter is total curvature at the apex of the cavity surface. For given values of downward seepage velocity, cavity radius, saturated hydraulic conductivity, and of the sorptive number, the results permit one to determine whether or not seepage water will enter a spherical cavity. (See also W89-06576) (Author's abstract)
W89-06577

SOLUTIONS APPROXIMATING SOLUTE TRANSPORT IN A LEAKY AQUIFER RECEIVING WASTEWATER INJECTION,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 5B.
W89-06581

MULTIDIMENSIONAL STEADY INFILTRATION TO A WATER TABLE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2G.
W89-06585

REGIONAL SCALE TRANSPORT IN A KARST AQUIFER: 1. COMPONENT SEPARATION OF SPRING FLOW HYDROGRAPHS,
California Univ., Santa Cruz. Dept. of Earth Sciences.
S. J. Dreiss.
Water Resources Research WRERAO, Vol. 25, No. 1, p 117-125, January 1989. 8 fig, 1 tab, 39 ref. NSF grant EAR 8307686-01.

Descriptors: *Ion transport, *Springs, *Karst hydrology, *Storm runoff, *Missouri, *Aquifers, *Hydrographys, Discharge hydrographs, Calcium, Magnesium, Aquifer characteristics, Water chemistry.

Large fluctuations in Ca and Mg concentrations occur in the discharge of karst springs in southeastern Missouri after major storm events. Rapid flow of relatively dilute, storm-derived water through solution conduits in the aquifer causes the fluctuations in chemistry. A cation balance for the discharge of one spring indicated that about 25% of the total spring flow is storm-derived water. These storm-derived contributions reach a maximum during the recession of storm responses in the spring flow hydrograph. At the peak of the responses, spring flow is composed primarily of prestorm water that has been displaced in the conduit system by the storm-derived water. The observed chemical fluctuations and hydrograph components differ from those observed in stream flow where the time of the maximum dilution usually coincides with the time of peak discharge. (See also W89-06587) (Author's abstract)
W89-06586

REGIONAL SCALE TRANSPORT IN A KARST AQUIFER: 2. LINEAR SYSTEMS AND TIME MOMENT ANALYSIS,
California Univ., Santa Cruz. Dept. of Earth Sciences.
S. J. Dreiss.
Water Resources Research WRERAO, Vol. 25, No. 1, p 126-134, January 1989. 5 fig, 1 tab, 28 ref. National Science Foundation, Environmental Geosciences Program Grant EAR 8307686-01.

Descriptors: *Springs, *Ion transport, *Karst hydrology, *Missouri, *Groundwater movement, *Tracers, Aquifers, Mathematical analysis, Aquifer characteristics, Traveltime, Discharge hydrographs.

Travel time distributions of water or tracers in conduit-type karst aquifers can be found from linear systems analysis of either tracer test data or naturally occurring fluctuations in springflow chemistry. The chemical fluctuations at Maramec Spring, Missouri and results from a previous tracer test were used to derive a set of kernel functions that represent regional scale transport in the karst conduit network. A single kernel is sufficient to simulate the storm-derived component of Maramec springflow, suggesting that rapid transport in the conduit network is well-approximated by temporal stationarity. Time moment analysis of the kernels leads to several conclusions. The kernel for the tracer test exhibits a larger mean residence time and much smaller variance than the kernels derived from nonpoint source recharge. Thus the tracer travel distance appears to be longer than the mean travel distance of rapid recharge and much of the variance of nonpoint source kernels apparently results from the distribution of flow path lengths to the spring. By assuming an effective transport model and comparing the moments of the empirical tracer test kernel to the moments of the impulse response of the model, an effective velocity between the tracer input point and Maramec Spring of 1.3 km/day and an effective dispersivity of 0.29 km was computed. Because the time moments of the kernels and the effective transport parameters can be computed from readily measured springflow properties, they may prove to be a convenient means for studying and comparing regional scale transport in karst aquifers. (See also W89-06586) (Author's abstract)
W89-06587

APPROACH TO ESTIMATING HYDRAULIC CONDUCTIVITY SPATIAL CORRELATION SCALES USING GEOLOGICAL CHARACTERISTICS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
F. M. Phillips, and J. L. Wilson.
Water Resources Research WRERAO, Vol. 25, No. 1, p 141-143, January 1989. 10 ref.

Descriptors: *Hydraulic conductivity, *Estimating, *Geologic mapping, *Statistical methods, *Geostatistics, *Subsurface mapping, Correlation, Groundwater movement.

The estimation of hydraulic conductivity and other correlation scales by traditional geostatistical methods requires a large number of field measurements at appropriate horizontal and vertical spacings. In order to extend the application of stochastic subsurface hydrology analysis to situations where such data are limited, an approach to correlation scale estimation is proposed that incorporates geological mapping. Regions of the formation with hydraulic conductivity values above (or below) some specified cutoff value are mapped and their dimensions are related to the correlation scale, by means of threshold-crossing theory. The ability to incorporate geological expertise of a subjective nature into the estimation of quantitative geostatistical parameters would be a significant advance. Field studies will be the true test of the value of the proposed approach. (Author's abstract)
W89-06589

WORKSHOP DESIGN FOR SPRING CAPPING: A TRAINING GUIDE,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 4B.
W89-06603

WORKSHOP DESIGN FOR WELL IMPROVEMENT: PROTECTING OPEN WELLS,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 4B.
W89-06604

REVIEW OF INTERMEDIATE-SCALE EXPERIMENTS FOR SUBSURFACE MICROBIOLOGY AND CHEMISTRY,
Battelle Pacific Northwest Labs., Richland, WA.
For primary bibliographic entry see Field 5B.
W89-06623

ANNOTATED BIBLIOGRAPHY ON WELLHEAD PROTECTION PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 10C.
W89-06640

K-1407-B AND K-1407-C GROUNDWATER ASSESSMENT PLAN,
Oak Ridge Gaseous Diffusion Plant, TN.
For primary bibliographic entry see Field 5B.
W89-06644

APPLICATION OF THE OZONE-HYDROGEN PEROXIDE COMBINATION FOR THE REMOVAL OF TOXIC COMPOUNDS FROM A GROUNDWATER,
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
For primary bibliographic entry see Field 5F.
W89-06786

GEOLOGY AND HYDROLOGY OF THE ONONDAGA AQUIFER IN EASTERN ERIE COUNTY, NEW YORK, WITH EMPHASIS ON GROUND-WATER-LEVEL DECLINES SINCE 1982,
Geological Survey, Ithaca, NY. Water Resources Div.
W. W. Staubitz, and T. S. Miller.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4317, 1987. 44p, 7 fig, 12 tab, 4 plates, 22 ref.

Descriptors: *Water table decline, *Geohydrology, *Onondaga aquifer, *Groundwater level, *New York, Groundwater movement, Well yield, Sinks, Aquifers, Karst, Seasonal variation, Hydrology, Groundwater budget, Groundwater recharge.

The Onondaga aquifer is a nearly flat-lying, 25- to 110-foot-thick, cherty limestone with moderately developed karst features such as sinkholes, disappearing streams, and solution-widened joints. Most groundwater moves through solution-widened bedding planes, although some moves through vertical joints. The yield of water from 42 wells ranges from 3 to 100 gal/min, averaging 20 gal/min. Groundwater levels in the Onondaga aquifer declined during the fall of 1981 and summer and fall of 1982-85, near a 2.2-mile-long and 800-foot-wide land surface depression in the eastern part of Erie County. More than 60 wells and several wetlands went dry and at least three sinkholes developed. Groundwater levels were measured in 150 wells during a high water level period in April 1984 and a low water period in October 1984. Water levels fluctuated 20 to 50 ft near the depression and near the quarries but fluctuated only 5 to 10 ft elsewhere. The water level decline was caused by the combined effect of groundwater removal by pumpage from a quarry (the water is then discharged to Dorsch Creek) and by the swallets in the 2.2-mile-long depression area, which are recharge points for the aquifer. In 1982, sinkholes formed in a surface depression area in Harris Hill. The enlargement of these sinkholes seems to be unrelated to the water level decline in the eastern part of the county and is probably caused by local drainage alterations. (Author's abstract)
W89-06829

GEOHYDROLOGY AND SIMULATED RESPONSE TO GROUND-WATER PUMPAGE IN CARSON VALLEY, A RIVER-DOMINATED BASIN IN DOUGLAS COUNTY, NEVADA, AND ALPINE COUNTY, CALIFORNIA,
Geological Survey, Carson City, NV. Water Resources Div.
D. K. Maurer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4328, 1986. 109p, 26 fig, 13 tab, 2 plates, 33 ref.

Descriptors: Surface-groundwater relations, *Model studies, *Geohydrology, *Simulation analysis, *Groundwater mining, *Carson River, *Nevada, *California, Aquifers, Hydraulic models, Groundwater recharge, Evapotranspiration, Groundwater level, Water use, Groundwater budget, Groundwater irrigation.

A numerical model was used to simulate the effect of development of the groundwater reservoir in Carson Valley on Carson River outflow, evapotranspiration, and groundwater levels and storage. The basin-fill groundwater reservoir consists of: (1) confined and unconfined sedimentary deposits of Quaternary age that underlie the valley floor, and (2) sedimentary deposits of Tertiary age that are exposed mainly on the east side of the valley. Water levels indicate the presence of two confined aquifer systems: one < 100 ft deep, and the other, generally deeper than 200 ft. The basin-fill reservoir is surrounded by bedrock that transmits recharge to the basin through weathered and fractured zones near the contact between bedrock and valley fill. Estimates were made of the distribution of hydraulic properties of aquifer materials, and of the components of inflow to and outflow from the basin-fill reservoir. Inflow components consisted of the following approximate quantities, in acre-ft/yr: (1) mainstem Carson River flow, 360,000; (2) direct precipitation, 70,000; (3) runoff from perennial and ephemeral streams, 24,000: and (4) subsurface inflow, 38,000. Approximate estimates of outflow components were, in acre-ft/yr; (1) mainstem Carson River flow, 291,000; (2) potential evapotranspiration, 200,000. Both inflow and outflow totaled about 490,000 acre-ft/yr. These flow volumes show that the hydrologic regimen of the basin is dominated by surface water flow of the Carson River. Steady-state and transient calibration of the model provided an unacceptable fit of observed versus simulated groundwater level fluctuations and storage, and surface water outflow from the valley. These values provide a reasonable balance for the simulated steady-state water budget. Simulations show that surface water flow is the ultimate source of about 75% of pumped water for six scenarios of possible future groundwater development. Model simulations indicate that changes from agricultural to urban land uses could decrease the loss of Carson River outflow to pumpage when streamflow is not used for flood irrigation in that area. (Lantz-PTT)
W89-06834

SIMULATION OF THE GROUND-WATER FLOW SYSTEM AND PROPOSED WITHDRAWALS IN THE NORTHERN PART OF VEKOL VALLEY, ARIZONA,
Geological Survey, Tucson, AZ. Water Resources Div.
K. J. Hollett, and J. R. Marie.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4340, January 1987. 68p, 23 fig, 5 tab, 22 ref.

Descriptors: *Mathematical models, *Model studies, *Simulation analysis, *Groundwater depletion, *Arizona, *Groundwater movement, Vekol Valley, Geohydrology, Groundwater level, Groundwater management, Hydrologic models.

Pursuant to the Ak-Chin Indian Community Water Rights Settlement Act (Public Law 95-328-enacted on July 28, 1978) a study was undertaken to assess the effect of proposed groundwater withdrawal from Federal lands near the reservation. The first area to be evaluated was the northern part of the Vekol Valley. The evaluation was made using a numerical model based on detailed geohydrologic concepts developed during the study. The numerical model, which was calibrated to steady-state and transient groundwater conditions in the northern part of Vekol Valley, adequately duplicated the conceptual model and was used to estimate the effect of withdrawing approximately 174,000 acre-ft from the system during a 25-yr period. At the end of the 25-yr period, the water level was drawn down an average of about 95 ft, and about 150,5000 acre-ft of water was removed from storage. The 150,500 acre-ft of water represents 43% of the estimated recoverable groundwater in storage. (Author's abstract)
W89-06839

PLANNING REPORT FOR THE EDWARDS-TRINITY REGIONAL AQUIFER-SYSTEM ANALYSIS IN CENTRAL TEXAS, SOUTHEAST OKLAHOMA, AND SOUTHWEST ARKANSAS,
Geological Survey, Austin, TX. Water Resources Div.
P. W. Bush.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4343, 1986. 15p, 4 fig, 1 tab, 16 ref.

Descriptors: *Aquifer testing, *Groundwater, *Edwards aquifer, *Trinity aquifer, *Oklahoma, *Texas, *Arkansas, *Geohydrology, Aquifers, Hydrologic data, Geochemistry, Groundwater movement, Simulation analysis, Computer models, Hydrologic models, Groundwater depletion, Groundwater level, Project planning.

The Edwards-Trinity regional aquifer system supplies more than 0.78 million acre-ft/yr (700 million gal/day) of water for central Texas and small adjacent parts of southeast Oklahoma and southwest Arkansas. Current (1986) and future concerns about the aquifer system involve the ever-increasing demand for water, most of which is associated with rapid population increases. Decreases in, or elimination of, spring discharges and encroachment of water from downdip saline water zones into updip freshwater zones are of primary concern in the area underlain by the Edwards (Balcones Fault Zone) aquifer. Water level declines of several hundred ft in the Trinity aquifer are a serious concern in some metropolitan areas. The Edwards-Trinity regional aquifer-system analysis project, begun in October 1985 and scheduled to be completed by October 1991, is one of a series of similar projects being conducted nationwide. The project is intended to define the geohydrologic framework, and to describe the geochemistry and groundwater flow of the aquifer system in order to provide a better understanding of the system's long-term water yielding potential. A multidisciplinary approach will be used in which computer-based digital simulation of flow in the system will be the principal method of geohydrologic investigation. (Author's abstract)
W89-06840

GROUND-WATER FLOW NEAR TWO RADIOACTIVE-WASTE-DISPOSAL AREAS AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER, CATTARAUGUS COUNTY, NEW YORK--RESULTS OF FLOW SIMULATION,
Geological Survey, Albany, NY. Water Resources Div.
M. P. Bergeron, and E. F. Bugliosi.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4351, 1988. 30p, 16 fig, 2 tab, 16 ref.

Descriptors: *Groundwater movement, *Radioactive wastes, *Path of pollutants, *New York, *Model studies, *Disposal sites, Simulation analysis, Hydraulic conductivity, Flow profiles, Groundwater recharge, Geohydrology, Infiltration.

Two adjacent burial areas were excavated in a clay-rich till at a radioactive waste disposal site near West Valley in Cattaraugus County, N.Y.: (1) which contains mainly low-level radioactive wastes generated onsite by a nuclear fuel reprocessing plant, has been in operation since 1966; and (2) which contains commercial low-level radioactive wastes, was operated during 1963-75. Groundwater below the upper 3 meters of till generally moves downward through a 20- to 30-meter thick sequence of tills underlain by lacustrine and kame-delta deposits of fine sand and silt. Groundwater in the weathered, upper 3 meters of till can move laterally for several meters before either moving downward into the kame-delta deposits or discharging to the land surface. A two-dimensional finite-element model that simulates two vertical sections was used to evaluate hydrologic factors that control groundwater flow in the till. Conditions observed during March 1983 were reproduced accurately in steady-state simulations that used four isotropic units of differing hydraulic conductivity to represent two fractured and weathered till units near land surfaces, an intermediate group of isolated till zones that contain significant amounts of fine sand and silt, and a sequence of till units at depths that have been consolidated by overburden pressure. Recharge rates used in the best-fit simulation ranged from 1.4 cm/yr along smooth, sloping or compacted surfaces to 3.8 cm/yr near swampy areas. Values of hydraulic conductivity and infiltration used in the calibrated best-fit model were nearly identical to values used in a previous model analysis of the nearby commercial-waste burial area. Results of the model simulations of a burial pit assumed to be filled with water indicate that water near the bottom of the burial pit would migrate laterally in the shallow, weathered till for 5 to 6 meters before moving downward into the unweathered till, and water near the top of the pit would move laterally less than 20 meters before moving downward into the unweathered till. These results indicate that subsurface migration of radionuclides in groundwater to points of discharge to land surface is unlikely as

long as the water level does not rise into the reworked cover material. (Author's abstract)
W89-06841

SELECTED CHEMICAL ANALYSES OF WATER FROM FORMATIONS OF MESOZOIC AND PALEOZOIC AGE IN PARTS OF OKLAHOMA, NORTHERN TEXAS, AND UNION COUNTY, NEW MEXICO,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 2K.
W89-06843

OVERVIEW OF WATER RESOURCES IN OWENS VALLEY, CALIFORNIA,
Geological Survey, Sacramento, CA. Water Resources Div.
L. S. Rogers.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4357, 1987. 38p, 32 fig, 3 tab, 19 ref.

Descriptors: *Water resources data, *Owens Valley, *Groundwater budget, *California, *Groundwater level, *Geohydrology, Evapotranspiration, Groundwater recharge, Precipitation, Groundwater depletion, Wells.

In 1982-84, a water resources appraisal of Owens Valley was made by using available hydrologic information. Results of the appraisal provided an overview of water resources in Owens Valley; a better understanding of the groundwater system; and a framework for additional studies. Owens Valley is in east-central California and is the major source of water supply for the city of Los Angeles, located 233 mi to the south. Since 1913, with the completion of the first aqueduct, surface water has been diverted from the Owens River to Los Angeles. In 1970, a second Aqueduct was completed. Groundwater pumping was increased to supplement the water needed for the increasing population in Los Angeles. Most of the outflow of water from Owens Valley is from exports via the aqueduct system and by evapotranspiration loss; principal sources of water are runoff, inflow from Pleasant Valley Reservoir, and precipitation. Streamflow from the Sierra Nevada is a source of tremendous quantities of water to the valley. Pumping from more than 90 pump-equipped wells averaged about 98,000 acre-ft/yr from 1971 to 1983, but it was generally < 10,000 acre-ft/yr from 1932 to 1970, except during dry years. Groundwater pumping is primarily from deep wells adjacent to the volcanic rocks near Big Pine. Wells completed in the volcanic rocks yield large quantities of groundwater. Water level fluctuations in deep wells indicate a direct correlation with groundwater pumpage. Fluctuations in shallow wells are affected not only by pumping, but also by evapotranspiration and precipitation. The cause-and-effect relation of water level fluctuations in deep and shallow wells is not well understood and is partly the subject of a 5-yr study currently being conducted by Inyo County, the city of Los Angeles, and the U.S. Geological Survey, which emphasizes: (1) vegetation, (2) plant survivability, and (3) groundwater. It is hoped that this study will better define the quantity and availability of groundwater in the valley, as well as determine the effects of groundwater withdrawals on native vegetation. (Lantz-PTT)
W89-06844

HYDROGEOLOGY OF STRATIFIED-DRIFT AQUIFERS AND WATER QUALITY IN THE NASHUA REGIONAL PLANNING COMMISSION AREA, SOUTH-CENTRAL NEW HAMPSHIRE,
Geological Survey, Bow, NH. Water Resources Div.
K. W. Toppin.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4358, 1987. 101p, 16 fig, 7 tab, 6 maps, 65 ref.

Descriptors: *Water quality, *Water resources data, *Geohydrology, *Groundwater movement, *Aquifers, *Groundwater quality, *New Hampshire, Water pollution sources, Fate of pollutants, Groundwater pollution, Iron, Manganese, Sodium, Dissolved solids, Drinking water, Hydrogen ion concentration, Transmissivity.

The Nashua Regional Planning Commission area in south-central New Hampshire is a 12-community area that is experiencing increases in population and in demands for water supply. The study area is underlain by 129 sq mi (40% of the area) of stratified drift which, where sufficiently saturated and permeable, form the most productive aquifers in the area. Eight towns use the stratified-drift aquifers for municipal water supply. The saturated thickness of stratified drift in the study area ranges from 0 or < 20 ft near aquifer boundaries to more than 100 ft in the Souhegan and Merrimack River valleys. The transmissivity of stratified drift ranges from < 2,000 sq ft/day throughout much of the area to more than 8,000 sq ft/day in the communities of Amherst, Brookline, Hollis, Hudson, Litchfield, Merrimack, Milford, Nashua, and Pelham. Directions of groundwater flow are generally from valley walls to surface waters, which act as drains for the stratified drift aquifers. The estimated total yield of community water-supply systems in the study area (surface and groundwater combined) is 22 mgd (million gallons per day). Analytical modeling indicates that an additional 12 mgd could be obtained from six aquifers located in the communities of Amherst, Litchfield, Merrimack, Milford, and Pelham. Other aquifers in the area, not modeled in the study, could also provide increased amounts of water especially where yields could be augmented by induced recharge of surface water. Groundwater quality in the study area is characterized by naturally elevated levels of iron (Fe) and manganese (Mn). Of 32 wells sampled, 7 exceeded EPA recommended drinking water limits for both Fe and Mn, and 3 wells exceeded the Mn limit only. The average total dissolved solids concentration for 32 samples was 121 mg/L. Groundwater in the area is slightly corrosive; pH's ranged from 5.0-7.3. Groundwater contamination has been detected at two 'Superfund' sites in the study area located in Milford and Nashua. At both sites, contamination of groundwater has caused the shutdown of municipal and private water supply wells. The widespread effect of applying highway deicing chemicals on groundwater quality is reflected by sodium (Na) concentrations that average 24 mg/L throughout the study area. At 11 of 32 sites sampled, EPA recommended limits for Na (20 mg/L) was exceeded. (Author's abstract)
W89-06845

GEOHYDROLOGY AND SUSCEPTIBILITY OF MAJOR AQUIFERS TO SURFACE CONTAMINATION IN ALABAMA; AREA 8,
Geological Survey, Montgomery, AL. Water Resources Div.
J. C. Scott, R. H. Cobb, and R. D. Castleberry.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4360, 1987. 65p, 10 fig, 2 tab, 1 plate, 22 ref.

Descriptors: *Groundwater pollution, *Geohydrology, *Aquifers, *Alabama, *Water pollution sources, Alabama River, Tallapoosa River, Groundwater recharge, Groundwater budget, Hydraulic properties, Potentiometric level, Surface water.

The U.S. Geological Survey, in cooperation with the Alabama Department of Environmental Management, is conducting a series of geohydrologic studies to delineate the major aquifers and their susceptibility to contamination in Alabama. This report delineates and describes the geohydrology and susceptibility of the major aquifers to contamination in Area 8--Autauga, Chilton, Elmore, Lowndes, and Montgomery Counties. The major aquifers in the study area are the Eutaw, Gordo, and Coker aquifers of Cretaceous age. One or more of these aquifers are sources of public water supply in each of the five counties. The recharge areas for these aquifers are in Autauga, Chilton, Elmore, and Montgomery and Prattville. Maximum groundwater use in the Prattville area is more than 8 mgd (million gallons per day). Estimated maximum groundwater withdrawal for all uses in the study area is about 65 mgd. The potentiometric map of the Gordo aquifer indicates that the Alabama River may serve as a recharging boundary to the Gordo aquifer along the flood plain of the river in the Montgomery-Prattville area. The river also is acting as a recharging boundary to the Eutaw and Coker aquifers, where the potentiometric surfaces in the aquifers have been lowered. All recharge areas for the major aquifers are susceptible to contamination from the surface. However, the areas that are highly susceptible to contamination extend from Jemison to Clanton in Chilton County where the Coker aquifer generally is < 100 ft below land surface, and the flood plains of the Alabama, Coosa, and Tallapoosa Rivers, which are underlain by alluvial deposits that are in hydraulic contact with the major aquifers. Within the highly susceptible areas, the areas especially susceptible to contamination are the flood plain of the Alabama River in the Montgomery area and the flood plain of the Tallapoosa River. Pumpage from the major aquifers in this area has significantly lowered the potentiometric surface in the aquifers resulting in a downward gradient between the major aquifers and the Alabama River and the alluvial deposits underlying the flood plain along the river. (Lantz-PTT)
W89-06846

CHEMICAL CHARACTERISTICS OF WATER IN THE SURFICIAL AQUIFER SYSTEM, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2K.
W89-06849

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN FLORIDA AND IN PARTS OF GEORGIA, SOUTH CAROLINA, AND ALABAMA, MAY 1985,
Geological Survey, Atlanta, GA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06850

LOUISIANA GROUND-WATER MAP NO. 1: POTENTIOMETRIC SURFACE, 1985, AND WATER-LEVEL CHANGES, 1983-85, OF THE CHICOT AQUIFER IN SOUTHWESTERN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06851

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE HIGH PLAINS AQUIFER, WEST-CENTRAL KANSAS, 1950 TO AVERAGE 1984-86,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06852

GROUND-WATER QUALITY IN WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
L. R. Larson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4034, 1984. 71p, 32 fig, 2 tab, 18 ref.

Descriptors: *Groundwater, *Water quality, *Wyoming, *Water analysis, Nitrates, Drinking water, Dissolved solids, Fluorides, Selenium, Manganese, Iron, Water pollution sources, Groundwater pollution.

Chemical quality data for selected constituents in the U.S. Geological Survey water quality file for about 2,300 groundwater sample sites in Wyoming are summarized. Dissolved solids, nitrate, fluoride, arsenic, barium, cadmium, chromium, lead, mercury, selenium, iron, and manganese concentrations

are summarized on a statewide basis. The major chemical quality problem limiting the use of Wyoming ground water is excessive dissolved-solids concentrations. Water from about 62% of the groundwater sites sampled exceeded the EPA's (1979) secondary drinking water standard of 500 mg/L for dissolved solids. Consequently, dissolved solids concentrations also are summarized by aquifer on a county-wide basis. The counties with the best quality water based on median dissolved solids concentrations are Teton and Laramie Counties. The counties with the highest dissolved solids concentrations are Hot Springs and Natrona Counties. However, all counties do have some groundwater samples with dissolved-solids concentrations less than the EPA's (1979) drinking water standard. Nitrate contamination is an uncommon but potentially dangerous groundwater problem. About 3% of the nitrate concentrations in Wyoming groundwater samples exceeded the EPA's (1975) primary drinking water standard of 10 mg/l (for nitrate, as nitrogen). A nitrate problem generally is caused by septic tank, feedlot, or barnyard drainage into shallow aquifers. Fluoride concentrations exceeded the primary drinking water standard in 14% of the groundwater samples. All counties had at least one sample with a fluoride concentration greater than the drinking water standard. The highest fluoride concentration (90 mg/L) was in water from a well completed in the Tipton Shale Member of the Green River Formation. Toxic trace elements generally have not been found in concentrations greater than the primary drinking water standards in groundwater samples, except for selenium. Concentrations in about 19% of the iron analyses and about 30% of the manganese analyses exceeded the secondary drinking water standards (EPA, 1979) of 300 micrograms/L for iron and 50 micrograms/L for manganese. Many activities of man in Wyoming such as waste disposal, coal mining, uranium mining and milling, oil refining, and crop irrigation and fertilization may have the potential for groundwater contamination. However, most of the data in the water quality file of the U.S. Geological Survey represent natural groundwater conditions. (Lantz-PTT)
W89-06855

PROJECTED WATER-LEVEL DECLINES IN THE OGALLALA AQUIFER IN LEA COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
D. P. McAda.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4062, (1984). 84p, 31 fig, 14 tab, 30 ref.

Descriptors: *New Mexico, *Water table decline, *Model studies, *Groundwater level, *Groundwater depletion, *Groundwater management, *Aquifers, Ogallala aquifer, Projections, Simulation analysis, Groundwater irrigation, Specific yield, Hydraulic properties, Hydraulic conductivity.

Simulations of predevelopment steady-state and historical pumping conditions were used to adjust a two-dimensional digital groundwater flow model. Projections of water level declines were made based on the condition of no additional development and the condition of 0.44% annual increase in irrigation withdrawals to 1990 and a 0.88% annual increase in non-irrigation withdrawals to 2020. Based on no additional development, projected maximum water level declines from 1980 were 31 ft in 2000 and 59 ft in 2020. The amount of recoverable water remaining in the aquifer as simulated by the model was 24.6 mil acre-ft in 2000 and 22.4 mil acre-feet in 2020, compared to an estimated 28 mil acre-ft in 1980. With increased withdrawals, projected maximum declines were 33 ft in 2000 and 67 ft in 2020. As simulated by the model, 24.4 mil acre-ft of recoverable water remained in 2000 and 21.8 mil acre-ft remained in 2020. The sensitivity of the model to variations in hydraulic conductivity, specific yield, and recharge was tested over their ranges of uncertainty. Projected water level declines were most sensitive to specific yield. In response to changes in specific yield, declines varied by as much as 6.2 ft from the standard simulation to 2020 with no additional development. (Author's abstract)
W89-06856

GEOHYDROLOGY OF THE DELAWARE BASIN AND VICINITY, TEXAS AND NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
S. F. Richey, J. G. Wells, and K. T. Stephens.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4077, 1985. 99p, 5 fig, 14 tab, 6 plates, 104 ref.

Descriptors: *Geohydrology, *Aquifers, *Delaware basin, *Texas, *New Mexico, Groundwater quality, Dissolved solids, Chlorides, Fluorides, Water use, Groundwater irrigation, Groundwater.

The Delaware Basin study area includes four major aquifers: Capitan aquifer, Rustler Formation, Santa Rosa Sandstone (Dockum Group), and aquifers in the Cenozoic alluvium. Water from the Capitan aquifer is used for domestic and irrigation purposes in Eddy County, New Mexico, and for irrigation and industrial purposes in Texas. Available analyses indicate that dissolved solids concentrations range from 303 to 31,700 mg/L, chloride concentrations range from 16 to 16,689 mg/L, and fluoride concentrations range from 0.5 to 3.0 mg/L. The Rustler Formation contains water that generally is not suitable for domestic use because of its salinity. Chloride concentrations range from 15 to 210,000 mg/L, and dissolved solids concentrations range from 286 to 325,800 mg/L. Fluoride concentrations range from 0.5 to 11.4 mg/L. Water from this aquifer is used for irrigation and stock watering where it is of suitable quality. The Santa Rosa Sandstone is the principal source of groundwater in the western third of Lea County and in the eastern part of Eddy County. In parts of Texas, the Santa Rosa Sandstone and the Cenozoic alluvium are hydraulically connected and are called the Allurosa aquifer. The Santa Rosa Sandstone-Allurosa aquifer is the source of municipal supply for the cities of Barstow, Pecos, Monahans, and Kermit, Texas. Water quality is variable. For those analyses where the Santa Rosa Sandstone is a distinct entity, chloride concentrations range from 10 to 4,800 mg/L, dissolved solids concentrations range from 205 to 2,990 mg/L, and fluoride concentrations range from 0.4 to 5.0 mg/L. Water from the Cenozoic alluvium is used extensively for public water supplies, irrigation, industry, livestock watering, and rural-domestic supply throughout the Delaware Basin. The quality of water in the Cenozoic alluvium is variable. Chloride concentrations range from 5 to 7,400 mg/L, dissolved solids concentrations range from 188 to 15,000 mg/L, and fluoride concentrations range from 0.3 to 10 mg/L. The Cenozoic alluvium is hydraulically connected to Cretaceous units in parts of Reeves and Pecos Counties, Texas; in these areas, the units are considered as one aquifer, the Pecos aquifer. (Author's abstract)
W89-06857

PROJECTED EFFECTS OF GROUND-WATER WITHDRAWALS IN THE ARKANSAS RIVER VALLEY, 1980-99, HAMILTON AND KEARNY COUNTIES, SOUTHWESTERN KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-06858

GROUND-WATER RESOURCES IN THE ROSS BARNETT RESERVOIR AREA, MISSISSIPPI,
Geological Survey, Jackson, MS. Water Resources Div.
W. T. Oakley.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4160, 1984. 32p, 14 fig, 4 tab, 18 ref.

Descriptors: *Water use, *Water resources data, *Groundwater resources, *Groundwater quality, *Ross Barnett Reservoir, *Mississippi, Aquifers, Groundwater budget, Groundwater recharge, Drinking water, Iron, Color, Wells.

The Ross Barnett Reservoir area occupies about 78 sq mi of a 490 sq mi study area northeast of the City of Jackson, MS. For several years, water use in the area has increased and during 1983 about 0.57 mil gal/day were obtained from groundwater sources. Virtually all groundwater in the area is used for public supplies. The principal aquifers currently used in the area are in the Sparta Sand and Cockfield Formations. The Sparta Sand is the most intensively developed and generally the highest yielding aquifer in the study area. Water level declines have averaged 2 to 3 ft/yr since 1940. The principal source of groundwater recharge to the aquifers is precipitation on outcrops of permeable strata northeast of the area. The base of freshwater is at the base of the Meridian-upper Wilcox aquifer except in the extreme northeast part of the area where the lower Wilcox aquifer contains freshwater. Water from the aquifers is suitable for public supply use without treatment except in a few places where iron concentrations are high, at from 0.10 to 9.3 mg/L. Excessive color is also a problem in the water from some wells in the area. Color was 20 units or greater in 8 of 25 wells sampled. (Author's abstract)
W89-06862

POTENTIAL EFFECTS OF SURFACE COAL MINING ON THE HYDROLOGY OF THE CIRCLE WEST COAL TRACTS, MCCONE COUNTY, EASTERN MONTANA,
Geological Survey, Helena, MT. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-06863

HYDROGEOLOGY AND GROUND-WATER QUALITY OF LANNON-SUSSEX AREA, NORTHEASTERN WAUKESHA COUNTY, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
R. D. Cotter.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4213, 1986. 28p, 10 fig, 3 tab, 6 ref.

Descriptors: *Geohydrology, *Groundwater, *Water quality, *Water resources data, *Wisconsin, Aquifers, Dolomite, Nutrients, Water quality, Calcium, Magnesium, Potassium, Sodium, Strontium, Alkalinity, Chlorides, Fluorides, Sulfates, Nitrites, Nitrates, Nitrogen, Iron, Manganese, Hardness, Hydrogen ion concentration, Confining beds.

The Silurian dolomite aquifer in the Lannon-Sussex area of southeastern Wisconsin is overlain by glacial deposits, but is within 8 ft of the land surface over 15% of the study area. The proximity of the dolomite aquifer to the land surface makes it susceptible to contamination from man's activities. Water from the aquifer was analyzed and several characteristics were monitored in a 30-sq-mi area of Waukesha County, including: water temperature, calcium, magnesium, potassium, strontium, alkalinity, chlorides, fluorides, sulfates, nitrites, nitrates, nitrogen, iron, manganese, hardness, and pH. The water is hard, commonly having a hardness of more than 350 mg/L as $CaCO_3$, and high in iron, commonly containing more than 0.3 mg/L. However, nutrient concentrations are not high; nitrogen, greater than 8 mg/L; phosphorus, none detected; and potassium, greater than 4 mg/L. The chloride content of the water averages more than 50 mg/L indicating contamination probably from septic systems. The water quality varies over a time. High concentrations of chloride and, occasionally, of bacteria correlate with periods of groundwater recharge over a period of 17 months. Chloride concentrations were highest in water from wells where housing density is high. An attempt was made to relate water quality changes with depth to beds of cherty dolomite that are identified in geologic logs; it was postulated that these zones might be confining beds. Although the beds appear to extend over the area, no evidence

was found that they are confining beds, other than reports of a few artesian wells. Water quality, indicated by chloride content, showed no significant relation to well bottom altitudes, casing bottom altitude, or well depth. (Author's abstract)
W89-06864

STREAMFLOW GAIN-AND-LOSS AND SUSPENDED-SEDIMENT CHARACTERISTICS OF THE SOUTH PLATTE RIVER AND THREE IRRIGATION CANALS NEAR FORT MORGAN, COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06865

QUALITY OF GROUND WATER IN THE PUGET SOUND REGION, WASHINGTON, 1981,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-06866

FINITE-ELEMENT SIMULATION OF GROUND-WATER FLOW IN THE VICINITY OF YUCCA MOUNTAIN, NEVADA-CALIFORNIA,
Geological Survey, Denver, CO. Water Resources Div.
J. B. Czarnecki, and R. K. Waddell.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4349, 1984. 38p, 8 fig, 5 tab, 2 plates, 60 ref.

Descriptors: *Model studies, *Finite element method, *Groundwater movement, *Nevada, *California, Yucca Mountain, Geohydrology, Hydrologic models, Aquifers, Hydraulic gradient, Transmissivity, Mathematical models, Franklin Lake, Timber Mountain, Furnace Creek Ranch.

A finite-element model of the groundwater flow system in the vicinity of Yucca Mountain at the Nevada Test Site was developed using parameter estimation techniques. The model simulated steady-state ground-water flow occurring in tuffaceous, volcanic, and carbonate rocks, and alluvial aquifers. Hydraulic gradients in the modeled area range from 0.00001 for carbonate aquifers to 0.19 for barriers in tuffaceous rocks. Three model parameters were used in estimating transmissivity in six zones. Simulated hydraulic-head values range from about 1,200 m near Timber Mountain to about 300 m near Furnace Creek Ranch. Model residuals for simulated versus measured hydraulic heads range from -28.6 to 21.4 m; most are less than +/-7 m, indicating an acceptable representation of the hydrologic system by the model. Sensitivity analyses of the model's flux boundary condition variables were performed to assess the effect of varying boundary fluxes on the calculation of estimated model transmissivities. Varying the flux variables representing discharge at Franklin Lake and Furnace Creek Ranch has greater effect than varying other flux variables. (Author's abstract)
W89-06868

THREE-DIMENSIONAL MODEL SIMULATION OF STEADY-STATE GROUND-WATER FLOW IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
J. M. Kernodle, and W. B. Scott.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4353, 1986. 58p, 19 fig, 3 tab, 64 ref.

Descriptors: *Model studies, *Groundwater movement, *Albuquerque-Belen basin, New Mexico, *Simulation analysis, Groundwater level, Hydraulic conductivity, Transmissivity, Groundwater basins, Steady flow.

As part of the Southwest Alluvial Basins study, model was constructed to simulate the alluvial aquifer system underlying the Albuquerque-Belen Basin. The model was used to simulate the steady-state flow condition assumed to have existed prior to 1960. Until this time there apparently were no long-term groundwater level changes of a significant magnitude outside the immediate vicinity of Albuquerque. Therefore, the construction of a steady-state flow model of the aquifer system based on reported hydrologic data predating 1960 was justified. During construction of the steady-state model, simulated hydraulic conductivity values were adjusted, within acceptable physical limits, until a best fit between measured or reported and computed heads at 34 control wells was achieved. The modeled area was divided into six sub-areas, or zones, within each of which hydraulic conductivity was assumed to be uniform. The model consisted of six layers for each of which simulated transmissivity was proportional to the layer thickness. Adjustments to simulated hydraulic conductivity values in the different zones resulted in final values that ranged from a low of 0.25 ft/day in the west to 50 ft/day in the eastern part of the basin. The error of the simulation, defined as the absolute difference between the computed and the measured or reported water level at the corresponding point in the physical system being modeled, ranged from 0.6 ft to 36 ft, with an average of 14.6 ft for the 34 control wells. (Author's abstract)
W89-06869

GROUND-WATER RESOURCE ASSESSMENT OF THE MONTAUK AREA, LONG ISLAND, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
K. R. Prince.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 85-4013, 1986. 103p, 36 fig, 11 tab, 2 plates, 43 ref.

Descriptors: *Water demand, *Coastal aquifers, *New York, *Long Island, *Water resources data, *Groundwater budget, Montauk, Long Island, Groundwater recharge, Aquifers, Hydraulic conductivity, Evapotranspiration, Runoff, Saline water intrusion, Flow profiles, Hydraulic models, Model studies, Water supply development.

The water resources of the Montauk area were investigated from October 1980 through September 1983 to assess the availability of fresh groundwater. The principal aquifer, which consists of fine- to coarse-grained stratified glacial drift, is the sole source of freshwater. The freshwater/saltwater interface lies as much as 150 ft below sea level, but the till unit and the marine-clay unit limit the thickness of the zone from which freshwater may easily be withdrawn to < 100 ft in most places. Precipitation, the sole source of freshwater in the Montauk area, averages about 42 in/yr. Direct runoff is approximately 1 in/yr, and evapotranspiration about 20 in/yr; the remaining 21 inches is the net recharge to the principal aquifer. The horizontal hydraulic conductivity, as calculated from specific-capacity data, ranges from 130 to 350 ft/d. Analysis of an aquifer pumping test indicates that horizontal hydraulic conductivity of the principal aquifer is approximately 275 ft/d and the vertical hydraulic conductivity is approximately 90 ft/d; the storage coefficient ranges from 1.1 x .001 to 2.2 x .001. A numerical two-dimensional flow model that simulates the areal flow of fresh- and saltwater was developed to evaluate the effects of the present level of groundwater development and the potential effects of increased future withdrawals. Model results indicate that the principal aquifer is capable of producing several times more than the 0.6 mil gal/d now being withdrawn for public supply. Examination of well design and pumping rates, and analysis of analog-model studies of saltwater upconing to wells, indicate that the peak pumping rate of public supply wells exceeds the limit necessary to avoid contamination from saltwater. With proper well design and distribution of pumping stress, the aquifer system would be capable of supplying enough water to meet the needs of the population projected through 1995. (Author's abstract)
W89-06870

GROUND-WATER SYSTEM AND SIMULATED EFFECTS OF GROUND-WATER WITHDRAWALS IN NORTHERN UTAH VALLEY, UTAH,
Geological Survey, Salt Lake City, UT. Water Resources Div.
D. W. Clark.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 85-4007, 1984. 56p, 27 fig, 7 tab, 12 ref.

Descriptors: *Geohydrology, *Model Studies, *Groundwater depletion, *Simulation analysis, *Environmental effects, *Utah Valley, *Utah, Computer models, Groundwater level, Groundwater recharge, Wells.

The effects of withdrawals were projected by means of a, 3-D finite difference, digital-computer model, which was constructed to aid understanding of the groundwater system and to simulate groundwater flow. The model was compared with water levels measured in 1947, and observed water level changes from 1947-83. The model was used to evaluate groundwater data presented in previous reports, to simulate varying quantities of groundwater withdrawal and recharge, and to estimate water level changes for 1980-2000. The average annual rate of recharge for the area is assumed to be 190,000 acre-ft/yr, and the average annual discharge from wells at the end of transient-state calibration was assumed to be 50,100 acre-ft/yr. Water level declines of as much as 25 feet are projected for the 20-year period if the average recharge rate is assumed and discharge from wells is as much as 91,400 acre-ft/yr. During transient-state calibration, changes in recharge to the principal groundwater reservoir were shown to be a major cause of the variations in water levels. (Author's abstract)
W89-06871

POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER AND ITS USE IN MANAGEMENT OF WATER RESOURCES, ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06873

GEOHYDROLOGY OF THE GLACIAL-OUTWASH AQUIFER IN THE BALDWINSVILLE AREA, SENECA RIVER, ONONDAGA COUNTY, NEW YORK,
Geological Survey, Ithaca, NY. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06877

SIMULATED WATER LEVEL DECLINES CAUSED BY GROUNDWATER WITHDRAWALS NEAR HOLLOMAN AIR FORCE BASE, OTERO COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 4B.
W89-06883

GEOHYDROLOGY AND 1985 WATER WITHDRAWALS OF THE AQUIFER SYSTEMS IN SOUTHWEST FLORIDA, WITH EMPHASIS ON THE INTERMEDIATE AQUIFER SYSTEM,
Geological Survey, Tampa, FL. Water Resources Div.
A. D. Duerr, J. D. Hunn, B. R. Lewelling, and J. T. Trommer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4259, 1988. 115p, 31 fig, 2 tab, 83 ref.

Descriptors: *Geohydrology, *Carbonate aquifers, *Florida, Potentiometric level, Water use, Wells, Southwest Florida Water Management District.

In southwest Florida, principal hydrogeologic units include the surficial aquifer system, the intermediate aquifer system, and the Floridan aquifer system. The Floridan aquifer system consists of the Upper and Lower Floridan aquifers separated by a middle confining unit. The intermediate aquifer system includes all water-bearing units and confining units between the overlying surficial aquifer system and the underlying Floridan aquifer system. Thickness of the surficial aquifer system ranges from 25 to 250 ft and thickness of the intermediate aquifer system ranges from less than 100 to more than 800 ft. Transmissivity of the intermediate aquifer system ranges from less than 200 to about 12,000 sq ft/day. In the northern part of the study area, the potentiometric surface of the intermediate aquifer system is higher than the potentiometric surface of the underlying Upper Floridan aquifer. Water is transmitted downward through the confining unit and recharges the Upper Floridan aquifer. The gradient in head reverses in the southern part of the study area. In 1985, an estimated 808 million gal/day of freshwater was withdrawn from all aquifers in the study area for irrigation, public and rural supply, and industrial use. Of this total, an estimated 68.9 million gal/day was withdrawn from the intermediate aquifer system. (USGS)
W89-06887

GROUNDWATER WITHDRAWAL AND WATER LEVEL DATA USED TO SIMULATE REGIONAL FLOW IN THE MAJOR COASTAL PLAIN AQUIFERS OF NEW JERSEY,
Geological Survey, Trenton, NJ.
O. S. Zapecza, L. M. Voronin, and M. Martin.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4038, 1987. 120p, 10 plates, 11 fig, 22 tab.

Descriptors: *Pumpage, *Water level fluctuations, *New Jersey, *Coastal Plains, *Groundwater, *Potentiometric maps, Hydrographs, Coastal aquifers, Confined aquifers, Water table, Aquifer systems, Geohydrologic units.

The report documents groundwater withdrawal and level data for the major aquifers of the New Jersey Coastal Plain. These data have been used in the Regional Aquifer System Analysis flow model of 10 major aquifers in the New Jersey Coastal Plain. Groundwater withdrawal data from more than 1,400 wells are tabulated by year for 1956 through 1980. Total yearly withdrawals for 171 public supply and industrial purveyors for 1918 through 1955 are documented. Best estimates are given for percentages of total withdrawals by aquifer for the 1918 through 1955 data. Groundwater withdrawal data is also tabulated yearly from 1918 through 1980 by county for each aquifer. Long-term hydrographs for 89 Coastal Plain wells provide information on water level fluctuations over time. Potentiometric maps showing earliest recorded water levels in Coastal Plain aquifers delineate prepumping conditions. Groundwater withdrawals from the Coastal Plain have increased from less than 50 million gal/day in 1918 to more than 350 million gal/day in 1980. In response to these increased withdrawals, groundwater levels have been steadily declining. In some areas where wells once flowed freely, water levels are now 100 to 200 ft below land surface. (USGS)
W89-06889

NATIONAL WATER SUMMARY 1986: HYDROLOGIC CONDITIONS AND GROUNDWATER QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2A.
W89-06890

WATER RESOURCES OF THE ZUNI TRIBAL LANDS, MCKINLEY AND CIBOLA COUNTIES, NEW MEXICO,
Geological Survey, Las Cruces, NM. Water Resources Div.
B. R. Orr.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Supply Paper 2227, 1987. 76p, 25 fig, 2 pl, 5 tab, 58 ref.

Descriptors: *Water resources, *Indian lands, *Zuni Tribe, *New Mexico, *Hydrologic data, *Water resources data, *Groundwater data, Water quality, Groundwater, Data collections, Aquifers.

An evaluation of the water resources of the Zuni tribal lands in west-central New Mexico was made to determine the yield, variability, and quality of water available to the Pueblo of Zuni. Rocks of Permian to Quaternary age supply stock, irrigation, and domestic water to the Zuni Indians. The Glorieta Sandstone and San Andres Limestone (Glorieta-San Andres aquifer) of Permian age and sandstones in the Chinle Formation of Triassic age provide most of this water supply. Water in the Glorieta-San Andres aquifer is confined by minimal-permeability shales and is transmitted through the aquifer along interconnected solution channels and fractures. Water level and water quality information indicate greater hydraulic conductivities along the southern boundaries of Zuni tribal lands. Well yields from the Glorieta-San Andres aquifer are as much as 150 gal/min, and aquifer transmissivity ranges from 30 to 1,400 sq ft/day. Long-term, water level declines of as much as 29 ft have been measured near pumping centers at Black Rock. Multiple-well aquifer tests are needed to define aquifer properties (storage, transmissivity, and leakage from confining units) further and the effects of well design on well yields. Dissolved-solids concentrations in water from the aquifer range from 331 to 1,068 mg/L. Calcium and sulfate are the predominant ions. Water in sandstones of the Chinle Formation is confined by adjacent shales and is transmitted along interconnected fractures. Well yields range from 5 to 125 gal/min, and aquifer transmissivity ranges from 40 to 1,400 sq ft/day. Water level declines of as much as 27 ft have been measured near Zuni Village. Dissolved-solids concentrations in water from the aquifer range from 215 to 1,980 mg/L. Sodium and bicarbonate are the predominant ions. Other sources of groundwater were used primarily for livestock watering by means of windmills, with the exception of buried alluvial channel deposits along the Rio Pescado. These deposits provide domestic and irrigation water through springs and wells to Pescado and Black Rock. The Bidahochi Formation of Miocene and Pliocene age could potentially provide an additional supply of water chemically suitable for most uses. Seismic-reflection techniques are being used to locate buried channels eroded in the rocks underlying the Bidahochi Formation. These buried channels may contain thicker sections of saturated sands and gravels that could be developed for stock and domestic use. (USGS)
W89-06891

GROUNDWATER IN THE SOUTHEASTERN UINTA BASIN, UTAH AND COLORADO,
Geological Survey, Salt Lake City, UT. Water Resources Div.
W. F. Holmes, and B. A. Kimball.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Supply Paper 2248, 1987. 47p, 26 fig, 12 tab, 45 ref.

Descriptors: *Oil shale, *Geohydrology, *Water quality, *Hydrologic budget, *Ion exchange, *Utah, *Model studies, *Finite-difference models, Evapotranspiration, Chemical precipitation, Uinta Basin, Uinta County.

The potential for developing oil-shale resources in the southeastern Uinta Basin of Utah and Colorado has created the need for studies of the quality and quantity of water. This report treats the groundwater in the area. Groundwater occurs in three major aquifers. Alluvial aquifers are present in valley-fill deposits of major drainages. Consolidated-rock aquifers include the Bird's Nest aquifer in the Parachute Creek Member of the Green River Formation and the Douglas Creek aquifer, which includes parts of the Douglas Creek Member of the Green River Formation and parts of the Wasatch Formation. A digital-computer model of the flow system was used to evaluate the effects of withdrawals for oil-shale development on the consolidated-rock aquifers. The results of model simulation indicate that the Bird's Nest aquifer could supply about 10,000 acre-ft/year for 20 years at Federal lease tracts Ua and Ub, and the Douglas Creek aquifer could supply about 160 acre-ft/year. Water levels would be down 250 and 500 ft in the two aquifers, respectively, after 20 years of withdrawal at these rates. Chemical quality of the groundwater varies considerably. The changes in chemical composition can be attributed to several physiochemical processes, including mineral precipitation and dissolution, oxidation and reduction, mixing, ion exchange, and evaporative concentrations. Computer modeling of these processes shows how they account for the variability in the groundwater quality. (USGS)
W89-06892

MICROCOMPUTER PROGRAM FOR ESTIMATING DROUGHT STREAM-FLOW REDUCTION DUE TO PUMPING FROM NEARBY WELLS,
Georgia Univ., Athens. School of Forest Resources.
For primary bibliographic entry see Field 2A.
W89-06894

OPTIMAL SCHEMES FOR GROUNDWATER QUALITY MONITORING IN THE SHALLOW AQUIFER, DOUGHERTY PLAIN, SOUTHWESTERN GEORGIA,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-06896

HYDROGEOLOGY OF THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS,
Geological Survey, San Antonio, TX. Water Resources Div.
R. W. Maclay, and T. A. Small.
Available from Books and Open File Report Section, USGS, Box 25425, Denver CO 80225. Texas Water Development Board, Austin, Report 296, 1986. 90p, 23 fig, 9 tab, 77 ref.

Descriptors: *Geohydrology, *Aquifers, *Texas, *Groundwater movement, *Edwards aquifer, Permeability, Porosity, Data collections.

Hydrostratigraphic subdivisions of the highly productive Edwards aquifer in the San Antonio area of south Texas provide a basis for defining the nonhomogeneity of the aquifer and determining its hydraulic characteristics. The aquifer is multilayered and faulted, and lateral circulation is through permeable hydrostratigraphic subdivisions that are hydraulically connected at places by permeable openings associated with high-angle, normal faults. The Edwards aquifer is vertically displaced for its entire thickness at places along major northeastward-trending faults. At these places, groundwater circulation is diverted toward the northeast. (USGS)
W89-06914

GROUNDWATER HYDROLOGY OF THE JASPER (MIOCENE) AQUIFER IN THE SOUTHEAST TEXAS COASTAL PLAIN,
Geological Survey, Austin, TX. Water Resources Div.
E. T. Baker.
Available from Books and Open File Report Section, USGS, Box 25425, Denver CO 80225. Texas Department of Water Resources Report 295, 1986. 64p, 25 fig, 1 tab, 14 ref.

Descriptors: *Groundwater, *Simulation, *Texas, *Geohydrology, Permeability coefficient, Transmissivity, Stratigraphy, Recharge, Water resources data, Jasper aquifer, Evangeline aquifer, Chicot aquifer.

The Jasper (Miocene) aquifer is one of several important hydrological units in the Gulf Coastal Plain of Texas. Because the Jasper aquifer underlies shallower aquifers in many areas, regional water withdrawals from the Jasper are not signifi-

cant; however, it is capable of yielding 3,000 gal/min or more of water to wells in certain areas. The Jasper is underlain by the Catahoula confining system and overlain by the Burkeville confining system. The Evangeline and Chicot aquifers, in turn, overlie the Burkeville and also are prolific water yielding aquifers. The groundwater hydrology of the Jasper in an area of about 20,000 sq mi was simulated by a two-dimensional digital model using a steady-state approach. The model represents hydrologic conditions prior to development by wells, when natural recharge equaled natural discharge. The model was calibrated by simulating the predevelopment potentiometric surface of the Jasper. Results of the calibration showed that the simulation closely agrees with historical records of water levels in most areas. Sensitivity analysis showed that the model is very sensitive to changes in hydraulic head in the Evangeline above the Burkeville and moderately to very sensitive to changes in recharge on the outcrop of the Jasper as well as to changes in vertical hydraulic conductivity of the Burkeville. It is slightly less sensitive to changes in transmissivity of the aquifer. (USGS)
W89-06915

GROUNDWATER WITHDRAWALS AND LAND SURFACE SUBSIDENCE IN THE HOUSTON-GALVESTON REGION, TEXAS, 1906-80,
Geological Survey, Houston, TX. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-06916

SIMPLE STOCHASTIC MODEL PREDICTING CONSERVATIVE MASS-TRANSPORT THROUGH THE UNSATURATED ZONE INTO GROUNDWATER,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-06918

HYDROLOGY OF THE OKEFENOKEE SWAMP WATERSHED WITH EMPHASIS ON GROUNDWATER FLOW,
Georgia Univ., Athens. Graduate School.
K. B. Yu.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8621702. Ph.D. Djssertation, 1986. 226p, 70 fig, 13 tab, 90 ref.

Descriptors: *Surface-groundwater relations, *Okefenokee Swamp, *Model studies, *Groundwater movement, *Groundwater runoff, *Hydrologic budget, *Swamps, Permeability coefficient, Sediment transport, Evapotranspiration, Simulation analysis, Model studies, Mathematical models.

Atmospheric and groundwater components of the water balance in the Okefenokee Swamp watershed were estimated. Hydraulic conductivities of sediments in the surficial aquifer were measured and spatial variations in groundwater leakage from that aquifer to the underlying principal artesian aquifer were calculated using Callahan's approach. Actual evapotranspiration (AET) from the watershed was estimated and groundwater flow patterns into the swamp were modeled using different aquifer horizontal to vertical hydraulic conductivity ratios, surficial aquifer dimensions, and swamp water levels. Seasonal and annual groundwater flow patterns and groundwater fluxes into the swamp were also modeled using a three-dimensional groundwater flow simulation model. It was demonstrated that groundwater beneath the swamp and the uplands is connected to the swamp water body through the peat covering the swamp floor. Long-term AET was estimated to be 987.68 mm/yr. The highest monthly AET was 118.5 mm in July and the lowest was 37.0 mm in December. (Cremmins-AEPCO)
W89-06925

GROUNDWATER CONTAMINATION ASSESSMENTS,
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 7A.
W89-06927

OPTIMAL WELL LOCATION IN A MULTI-AQUIFER GROUNDWATER SYSTEM,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-06946

STOCHASTIC ANALYSIS OF AQUIFER INTERCONNECTEDNESS, WITH A TEST CASE IN THE WILCOX GROUP, EAST TEXAS,
Texas Univ. at Austin. Graduate School.
G. E. Fogg.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8706002. Ph.D. Dissertation, 1986. 216p, 52 fig, 7 tab, 96 ref, append.

Descriptors: *Stochastic hydrology, *Aquifer characteristics, *Groundwater movement, *Permeability coefficient, Simulation analysis, Flow characteristics, Model studies, Sandstones, Geology, Monte Carlo method, Texas, Wilcox Group aquifer.

The two-dimensional spatial distribution and interconnectedness of high hydraulic conductivity (K) facies in a sandstone multiple-aquifer system were estimated geostatistically using conditional simulation to transform geologic data and interpretation into a quantitative form for groundwater modeling. Facies continuity was accounted for with a variogram and conditional simulation was applied along with two-dimensional cross sections of panels between wells to achieve efficient use of computer time and memory. The method was applied in a part of the Wilcox Group, a freshwater aquifer system overlying a gas field in Texas. Sand thickness picks from borehole resistivity logs were transformed to a continuous, normally distributed variable (Sr). Variogram analysis of Sr showed distinctly different degrees of facies continuity in two subunits. Conditional and unconditional simulations were then performed on one of the subunits to examine the sensitivity of the results to different variogram models, sand percent, and flow region length. Computerized scanning of realizations of sand distribution yielded information on block-to-block interconnectedness frequency, interconnection probability, and vertical and horizontal sandbody geometry statistics. Steady-state simulations of flow through the generated facies distributions provided statistics on equivalent and horizontal hydraulic conductivity. (Cremmins-AEPCO)
W89-06949

GROUNDWATER CONTAMINATION BY THE HERBICIDE ATRAZINE, WELD COUNTY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Microbiology and Environmental Health.
For primary bibliographic entry see Field 5B.
W89-06950

SOLUBILITY, MOBILITY AND PLANT UPTAKE OF TOXIC ELEMENTS IN RETORTED OIL SHALES AS AFFECTED BY RECARBONATION,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W89-06953

GROUNDWATER MAPPING: THE INFORMATION EXCHANGE BETWEEN MAP USERS AND MAP MAKERS,
Clark Univ., Worcester, MA. Dept. of Geography.
For primary bibliographic entry see Field 7C.
W89-06961

2G. Water In Soils

RESEARCH TOWARD AN OPERATIONAL PASSIVE MICROWAVE REMOTE SENSING SYSTEM FOR SOIL MOISTURE,
Agricultural Research Service, Beltsville, MD.
For primary bibliographic entry see Field 7B.
W89-05845

RUNOFF PROCESS ON A STEEP FORESTED SLOPE,
Tokyo Univ. of Agriculture and Technology (Japan). Dept. of Forestry.
For primary bibliographic entry see Field 2E.
W89-05848

UNSATURATED ZONE SOIL MOISTURE BEHAVIOR UNDER TEMPERATE HUMID CLIMATIC CONDITIONS: TENSIOMETRIC OBSERVATIONS AND NUMERICAL SIMULATIONS,
Tokyo Univ. (Japan). Inst. of Industrial Science.
K. Musiake, Y. Oka, and M. Koike.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 179-200, September 30, 1988. 20 fig, 1 tab, 10 ref.

Descriptors: *Soil water, *Temperate climate, *Model studies, *Infiltration, Numerical analysis, Hysteresis, Simulation, Tensiometers, Rainfall, Japan, Soil water suction.

Soil moisture behavior in the unsaturated zone in a temperate humid climate is discussed based on tensiometric observations in an experimental basin near Tokyo, Japan, and on related numerical simulations. Observations made at this site include: annual fluctuation of soil suction, hysteresis in relation to observed suction range, annual fluctuation of soil moisture, change of soil suction and moisture during rainless days, change of suction near the ground surface, and change of soil suction and moisture during rainfall. The hydraulic properties required for simulation were determined based on the results of laboratory tests on soil samples taken from the tensiometer site. Changes of potential profile in the unsaturated zone both during rainless periods and during rainfall were simulated by a numerical model using Richards' flow equation. The numerical simulation techniques proved to be adequate in analyzing the evaporation and infiltration processes under field conditions. The results obtained by the tensiometric measurements are complimented, and their reliability enhanced by, the numerical simulations. (Rochester-PTT)
W89-05849

WATER FLOW IN UNSATURATED SOIL IN LAYERED SLOPES,
National Research Inst. of Agricultural Engineering, Yatabe (Japan).
T. Miyazaki.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 201-214, September 30, 1988. 12 fig, 13 ref.

Descriptors: *Soil water, *Unsaturated soils, *Hydraulic conductivity, *Flow pattern, *Hydraulic models, Layered slopes, Infiltration, Percolation, Drainage, Artificial soils, Refraction law, Model studies.

The water flow in unsaturated soil in layered slopes sandwiching coarse materials was measured using inclined soil containers placed under a rain simulator. The refraction law of water flow in saturated soils was extended to the flow in unsaturated soils. The extended refraction law of water flow in saturated and unsaturated soils was applied to the flow at the interface between the Masa sandy loam and either the plant or gravel layer, using a jump condition and particular assumptions of hydraulic conductivity of materials. The data obtained on infiltration, steady percolation, and drainage in the soil containers could be explained well by the proposed new concept of saturated and unsaturated refraction flow. The work reported here is thought to be the first specifically designed to elucidate the effects of abrupt change of hydraulic conductivity on the flow of water in unsaturated soil slopes. (Author's abstract)
W89-05850

SOME EXPERIMENTAL RESULTS CONCERNING RAPID WATER TABLE RESPONSE TO SURFACE PHENOMENA,
Tsukuba Univ. (Japan). Inst. of Geoscience.
For primary bibliographic entry see Field 2F.
W89-05851

KINEMATIC WAVE CHARACTERISTICS AND NEW EQUATIONS OF UNSATURATED INFILTRATION,
Hokkaido Univ., Sapporo (Japan). Dept. of Civil Engineering.
T. Yamada, and M. Kobayashi.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 257-266, September 30, 1988. 6 fig, 1 tab, 10 ref.

Descriptors: *Infiltration, *Soil water, *Kinematic waves, *Hysteresis, *Capillary waves, *Soil water movement, Aeration zone, Mathematical analysis, Tracers, Mathematical equations, Numerical analysis.

Several characteristics of the physical mechanism for the vertical infiltration of water into a soil layer are described. It is shown that the vertical infiltration of soil moisture has kinematic wave properties similar to flood waves in rivers. According to the theory, the vertical moisture profile moves downward faster than tracers or fluid particles. This was confirmed by field observation. Also, the effects of hysteresis on infiltration were studied and new equations proposed for infiltration expressing hysteretic behavior. By numerical calculation, it is shown that the soil moisture profiles do not differ significantly whether the hysteresis is considered or not, but the profiles of capillary potential are affected by the hysteresis. Furthermore, it was determined that capillary potential advances vertically more rapidly than soil moisture. (Author's abstract)
W89-05853

ANALYSIS OF THREE-DIMENSIONAL GROUNDWATER FLOW IN THE NEAR-SURFACE LAYER OF A SMALL WATERSHED,
Saitama Univ., Urawa (Japan). Hydroscience and Geotechnology Lab.
For primary bibliographic entry see Field 2F.
W89-05855

EFFECTS OF SLOPE CONDITIONS ON DIRECT RUNOFF CHARACTERISTICS BY THE INTERFLOW AND OVERLAND FLOW MODEL,
Yamanashi Univ., Kofu (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05857

POTENTIAL CONTAMINANT MOVEMENT THROUGH SOIL JOINTS,
Soil Conservation Service, Washington, DC.
For primary bibliographic entry see Field 5B.
W89-05913

SELENATE TRANSPORT IN STEADY-STATE, WATER-SATURATED SOIL COLUMNS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W89-05932

ELUTION OF SELENIUM FROM CONTAMINATED EVAPORATION POND SEDIMENTS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 5B.
W89-05933

DEGRADATION OF FLUAZIFOP-BUTYL IN SOIL AND AQUEOUS SYSTEMS,
Turin Univ. (Italy). Ist. di Chimica Agraria.
For primary bibliographic entry see Field 5B.
W89-05949

FLOW OF WATER THROUGH ROOT-SOIL ENVIRONMENT,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. A. Marino, and J. C. Tracy.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 588-604, November 1988. 6 fig, 1 tab, 26 ref.

Descriptors: *Soil-water-plant relationships, *Soil environment, *Root zone, *Model studies, *Roots, *Soil water, *Flow, Simulation, Rainfall, Irrigation, Evaporation, Model studies, Differential equations, Finite element method, Model testing.

A model is developed for simulating the vertical movement of water through a crop's root system. The root-water flow model is then coupled to a variably-saturated flow model via a root extraction term that is a function of the water pressure gradient across the root-soil interface as well as soil and root parameters. The resulting root-soil water flow model is a coupled pair of partial differential equations that describe the macroscopic movement of water through a root-soil system. Rainfall, irrigation and evaporation are treated as sources of potential soil-surface flux. Solution of the model is accomplished using a Galerkin finite element method. The model is verified by comparing simulated and field measured soil-water content levels. The comparisons show a very good agreement between simulated and measured soil-water contents. The root extraction distribution, cumulative flow from an underlying water table, and sensitivity of model results to changes in root parameters are also analyzed. (Author's abstract)
W89-05958

TIME SOLUTION OF KINEMATIC-WAVE MODEL WITH STOCHASTIC INFILTRATION,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 3F.
W89-05959

HYDROLOGIC BALANCE MODEL USING NEUTRON PROBE DATA,
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
R. H. Cuenca.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 644-663, November 1988. 3 fig, 7 tab, 22 ref.

Descriptors: *Hydrologic models, *Hydrologic data collections, *Soil-water-plant relations, *Model studies, *Soil water, *Hydrologic budget, Soil properties, Neutron probe, Evapotranspiration, Soil profiles, Field capacity, Drainage computer programs.

A general model for evapotranspiration estimates based on neutron probe readings is presented. The model performs a hydrologic balance keeping the surface layer separate from the rest of the soil profile. Various model options are available for selection of field capacity and maximum periods of drainage of the soil profile. A separate subroutine is employed to estimate final soil moisture conditions for evapotranspiration periods not ending in neutron probe readings. The current version of the model has been developed as a flexible tool to estimate evapotranspiration under a variety of conditions in a large-scale regional evapotranspiration experiment. Earlier versions of the model were successfully applied in experiments to determine crop water production functions. The flexibility of the model allows it to be applied as an effective research tool when monitored soil moisture conditions are used to test parametrizations of various components of the hydrologic balance. (Miller-PTT)
W89-05961

SOIL ENVIRONMENT OF THE INTERTIDAL AREA IN THE WESTERSCHELDE,
Institute of Earth Sciences, Utrecht (Netherlands). Comparative Sedimentology Div.
For primary bibliographic entry see Field 2L.
W89-05982

NEAR SURFACE SOIL MOISTURE ESTIMATION FROM MICROWAVE MEASUREMENTS,
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol.
For primary bibliographic entry see Field 7B.
W89-06010

CHEMICAL AND MINERALOGICAL EFFECTS OF SALINE WATER MOVEMENT THROUGH A SOIL DURING EVAPORATION,
Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Sedimentologie et de Geochimie de la Surface.
C. Thellier, B. Fritz, H. Paquet, J. Y. Gac, and N. Clauer.
Soil Science SOSCAK, Vol. 146, No. 1, p 22-29, July 1988. 6 fig, 2 tab, 33 ref.

Descriptors: *Solute transport, *Saline water, *Evaporation, *Soil water, *Soil chemistry, *Mineralogy, Aquifers, Africa, Polders, Lake Chad, Soil solution, Mass transfer, Soil columns, Simulation analysis.

A column experiment was conducted in the field to determine the chemical effects of the evaporation of a shallow aquifer through a homogeneous sandy clay loam soil. The experimental arrangement simulated conditions found in the polders surrounding Lake Chad in Central Africa. To characterize the nature of the water transfer, oxygen isotopes were determined in the soil solution. Major soil elements, and soluble species were also measured as a function of depth. The data obtained indicated that water, moving upward by capillarity through the soil profile, induced the transfer of soluble ions from the lower column depths. Evaporation took place just below the soil surface, where soluble salts tended to accumulate; the concentration of the soil solution increased drastically, while some soluble species tended to precipitate. Thermodynamic simulation of direct evaporation of the aquifer water and mass balance calculations of the mass transfer during the experimentation suggested the formation of Mg-rich clay minerals at the surface of the soil. Detailed transmission electron microscope observations confirmed these results in showing tiny fibers around detrital particles and longer rigid palygorskitelike laths. Thus, even after a short time, water evaporation of a nonsaline shallow aquifer strongly affected the chemistry of the soil. (Author's abstract)
W89-06011

EFFECTS OF SIMULATED ACID RAIN ON SOIL AND LEACHATE ACIDIFICATION OF A LEXINGTON SILT LOAM,
California Univ., Berkeley. Dept. of Plant and Soil Biology.
For primary bibliographic entry see Field 5C.
W89-06012

MEASURING THE SPATIAL VARIABILITY OF SOIL HYDRAULIC CONDUCTIVITY USING AN AUTOMATIC NEUTRON MOISTURE GAUGE,
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France).
P. Moutonnet, E. Pluyette, N. El Mourabit, and P. Couchat.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1521-1526, November-December 1988. 6 fig, 4 tab, 16 ref.

Descriptors: *Soil moisture meters, *Soil water, *Hydraulic conductivity, *Regression analysis, Mathematical studies, Cadarache Nuclear Research Center, Durance River, Hydraulics.

Soil internal drainage was measured along a 100-m transect at the Cadarache Nuclear Research Center in France with 20 neutron probe access tubes at 5-m intervals using an automatic neutron moisture gauge and a tensiometer data logger. Geostatistical analysis of the measurement results (in terms of hydraulic conductivity, K, vs. water content, theta) at depths of 60 and 90 cm, showed no autocorrelation among the sites. Measurement

results related to depths of 120 and 150 cm were deleted because of the lack of a unit hydraulic gradient. Variance analysis indicated that the 60 and 90 cm layer values could be considered together as a unique soil layer. The exponential regression equation computed from 240 K(theta) pairs, gave a correlation coefficient of 0.90 for this soil layer The K variation coefficient between 32 and 40% theta was 75% for the 60 and 90 cm soil depths. This value is consistent with other published findings. (Author's abstract)
W89-06068

CONSTANT RATE RAINFALL INFILTRATION IN A BOUNDED PROFILE: SOLUTIONS OF A NONLINEAR MODEL,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
P. Broadbridge, J. H. Knight, and C. Rogers.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1526-1533, November-December 1988. 5 fig, 23 ref, 2 append.

Descriptors: *Infiltration, *Infiltration capacity, *Soil water, *Hydraulic properties, *Rainfall rate, Rainfall intensity, Interstitial water, Unsaturated flow, Ponding.

New exact solutions are presented to a versatile analytic nonlinear model of single phase vertical unsaturated flow during constant rate rainfall infiltration in a bounded soil profile with an impermeable base. The nonlinear flow equation in a fixed finite region is transformed to a linear diffusion problem with boundary conditions on a shrinking domain. The linear problem is treated by King's method of Laplace transform boosts. The analytic solutions illustrate the theoretical differences in the basement moisture build up when the water content dependence of the soil hydraulic properties varies from strong to weak. In soils whose hydraulic properties depend on soil water content, the soil water profile will develop an advancing wetting front. Soon after such a wetting front reaches the basement, the moisture content in that region will increase to saturation. In soils whose hydraulic properties depend more weakly on water content, the water content profile will exhibit a more gradual variation. In this case, the soil water diffusivity at intermediate soil water contents may be sufficiently large that a significant amount of infiltrating water reaches the basement, effecting moisture build up, before any wetting front has developed. When the rainfall rate exceeds a critical value, surface ponding precedes basement saturation. In this case, time to ponding is approximated by the expression for the infinite column. When the rainfall rate is less than the critical value (which is greater than the conductivity at saturation), basement saturation precedes surface ponding. In this case, the time to basement saturation is close to the time taken for the rainfall to fill the available pore space. (Davis-PTT)
W89-06069

SIMULATED TRANSPORT OF MULTIPLE CATIONS IN SOIL USING VARIABLE SELECTIVITY COEFFICIENTS,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2K.
W89-06070

INDEPENDENT CALIBRATION OF MECHANISTIC-STOCHASTIC MODEL FOR FIELD-SCALE SOLUTE TRANSPORT UNDER FLOOD IRRIGATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2K.
W89-06071

ESTIMATING SPATIAL PATTERNS IN WATER CONTENT, MATRIC SUCTION, AND HYDRAULIC CONDUCTIVITY,
Washington State Univ., Pullman. Dept. of Agronomy and Soils.
D. J. Mulla.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1547-1553, November-December 1988. 6 fig, 5 tab, 32 ref.

Descriptors: *Hydraulic conductivity, *Matric suction, *Soil water, *Statistical analysis, Geostatistics, Washington, Clay, Sand, Kriging.

A relatively rapid method was developed for surveying and estimating field scale variability of water content, hydraulic conductivity, and matric suctions using geostatistics. Two 660-m long transects located 8 km west of Steptoe, WA were intensively sampled at 5-m spacings for surface temperature. Soil samples were also collected to a depth of 12 cm at spacings of 20 m, and these were analyzed for sand, clay, and soil water content. The spatial variability in each property was described using spherical semivariograms. Kriging was used to estimate spatial patterns in clay and sand content along each transect at 5-m spacings. Spherical cross-semivariograms of surface temperature and water content were used along with cokriging techniques to estimate water content at 5-m spacings. The geostatistical estimates of spatial patterns in water content, clay content, and sand content were used for texture-based estimates of matric suction and hydraulic conductivity at 5-m spacings along both transects. A comparison of texture based and laboratory-based estimates of matric suction showed that although the two estimators gave similar spatial patterns and means they had significantly different standard deviations. If it is important for a researcher to make quantitative predictions of matric suction, laboratory-based estimates would be better than the texture-based estimates. If what is important is estimating spatial patterns in matric suction, the texture based estimator would be acceptable. (Author's abstract)
W89-06072

COMPARISON OF GAS DIFFUSIVITY MODELS FOR UNSATURATED POROUS MEDIA,
Royal Inst. of Tech., Stockholm (Sweden). Center for Environmental Sciences.
M. Collin, and A. Rasmuson.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1559-1565, November-December 1988. 12 fig, 18 ref, append.

Descriptors: *Diffusion coefficient, *Moisture content, *Soil types, *Soil water, Model studies, Diffusivity, Pores, Clays.

The effective gas diffusivity in a porous medium decreases rapidly with increasing water content. Comparisons were made between experimental diffusivity data for different materials at various moisture contents, and estimation methods from the literature. The estimation methods proposed by R. J. Millington and R. C. Shearer in 1971 gave the best predictions of the effective diffusivity. The methods were extended to account for the contribution of diffusion in the water filled pores. The method for aggregated media should be used for undisturbed clayey soils, and the method for non-aggregated media may be used for sandy soils and for other materials that are not aggregated, e.g., laboratory packed clayey soils. The experimental data show that very low effective diffusivities may be obtained in practice in soils with high moisture content. (Author's abstract)
W89-06074

PHOSPHORUS ADSORPTION BY KAOLINITE AND MONTMORILLONITE: I. EFFECT OF TIME, IONIC STRENGTH, AND PH,
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
For primary bibliographic entry see Field 2K.
W89-06077

PHOSPHORUS ADSORPTION BY KAOLINITE AND MONTMORILLONITE: II. ORGANIC ANION COMPETITION,
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
For primary bibliographic entry see Field 2K.
W89-06078

SALT-INDUCED MANGANESE SOLUBILIZATION IN CALIFORNIA SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-06082

DENITRIFICATION HYSTERESIS DURING WETTING AND DRYING CYCLES IN SOIL,
Rhode Island Univ., Kingston. Dept. of Natural Resources Science.
For primary bibliographic entry see Field 2K.
W89-06083

COMPARISON OF PERCOLATION TEST RESULTS AND ESTIMATED HYDRAULIC CONDUCTIVITIES FOR MOLLISOLS AND ALFISOLS,
Illinois Univ. at Urbana-Champaign. Dept. of Agronomy.
T. J. Bicki, T. E. Fenton, H. D. Luce, and T. A. Dewitt.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1708-1714, November-December 1988. 1 fig, 7 tab, 38 ref.

Descriptors: *Hydraulic conductivity, *Subsoil drainage, *Percolation tests, *Soil classification, Mollisols, Alfisols, Iowa, Biosequence, Vegetation, Forests, Prairies.

Percolation tests were performed on an array of biosequences, topo-drainage sequences, and stage of profile development sequences of soils in Iowa and results were compared to estimated subsoil hydraulic conductivities from Soil Interpretation Records. Within a biosequence, Mollisols had higher percolation rates and lower coefficients of variation than Alfisols. The difference in permeability was attributed to higher subsoil clay content, higher subsoil bulk density, more continuous argillans, and stronger subsoil consistence in Alfisols. High coefficients of variation for percolation rates in Alfisols were attributed to large diameter root channels, lateral flow of water on sloping sites, and increased distinctness of subsoil horizon boundaries. In soils without argillic horizons, percolation test results of topo-drainage sequences are similar and reflect similar morphological characteristics. Soil Interpretation Records assign slower estimated hydraulic conductivity to some topo-drainage sequences as drainage becomes more restrictive. Percolation rates decreased in topo-drainage sequences of soils with argillic horizons as drainage became more restrictive, even though morphological characteristics were similar. Differences in percolation rates within topo-drainage sequences may reflect errors inherent in the procedure. Additional permeability data is needed to quantify and more accurately estimate subsoil hydraulic conductivity. Criteria used to establish estimated hydraulic conductivity in Soil Interpretation Records should be applied consistently among biosequences and topo-drainage sequences. (Author's abstract)
W89-06085

USING TEXTURE AND OTHER SOIL PROPERTIES TO PREDICT THE UNSATURATED SOIL HYDRAULIC FUNCTIONS,
Stichting voor Bodemkartering, Wageningen (Netherlands).
J. H. M. Wosten, and M. T. Van Genuchten.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1762-1770, November-December 1988. 2fig, 2 tab, 39 ref, 1 append.

Descriptors: *Hydraulic conductivity, *Soilwater, *Soil classification, *Model studies, Netherlands, Silt, Clay, Organic matter, Density, Hydraulic functions.

The unsaturated hydraulic properties of soils are important (e.g. to estimate travel time from the soil surface to the groundwater table) but difficult to measure. Analytical expresssions for the soil water retention and hydraulic conductivity functions were fitted to experimental data for a wide range of soils in the Netherlands. Analysis of the data

showed the flexibility of the analytical expressions and also gave insight into how the different model parameters affect the calculated unsaturated hydraulic functions. Regression analyses were used to relate the estimated model parameters to more easily measured soil properties, such as bulk density and percentages silt, clay, and organic matter. After calibration, the relations were used to predict the hydraulic functions of soils for which only the more easily measured soil properties are available. Accuracy of the predictions was analyzed in terms of functional criteria which are relevant to practical management problems. The predictive regression models are useful for estimating the unsaturated soil hydraulic properties of large areas of land, but need improvement for application to specific sites. (Author's abstract)
W89-06086

SEQUENTIAL EXTRACTION OF IRON, MANGANESE, ALUMINUM, AND SILICON IN SOILS FROM TWO CONTRASTING WATERSHEDS,
Science Applications International Corp., Oak Ridge, TN.
R. W. Arnseth, and R. S. Turner.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1801-1807, November-December 1988. 3 fig, 2 tab, 31 ref.

Descriptors: *Hydraulic conductivity, *Soil water, *Geohydrology, *Weathering, *Leaching, *Permeability coefficient, *Soil classification, Minerals, Iron, Manganese, Aluminum, Silica, Watersheds, Tennessee, Oak Ridge, Flow pattern.

Soil samples from two contrasting forested watersheds on the U. S. Department of Energy Oak Ridge Reservation in Oak Ridge, TN, were chosen for selective extraction of organics, Fe, Mn, and aluminosilicates. The extracts were analyzed for Fe, Mn, Al, and Si, and the results were evaluated in terms of pedogenic processes. The clay mineralogy was determined on a subset of the samples. Differences between the watersheds were observed in clay mineralogy and in the vertical distribution of extractable Mn. Walker Branch soils, developed on Knox Group carbonates, exhibit vertical flow paths capable of transporting soluble Mn deep in the profile before precipitation. Physically separated zones of Mn and Fe precipitation are observed in Walker Branch cores wherein mid-depth maxima in citrate-bicarbonate-dithionite (CBD)-extractable Fe are not mimicked in the Mn-specific extractable Mn profiles. Melton Branch soils, developed on shaly carbonates of the upper Maryville Limestone, with shaly residua persisting to the surface in some areas, retain a structure that obstructs vertical flow, forces lateral flow, and provides microenvironments for water stagnation. When these microenvironments experience periodic desiccation and oxidation, Fe- and Mn-oxyhydroxides are precipitated and coprecipitated. Therefore, clay mineralogy reflected differences in parent material whereas differences in the distribution of extractable Mn-oxyhydroxides probably reflect the distribution of soil microenvironments conducive to Mn accumulation and oxidation with implications for soil water flow patterns. (Author's abstract)
W89-06087

HYDROLOGY AND SOIL FERTILITY OF DEGRADED GRASSLANDS AT CHERRAPUNJI IN NORTHEASTERN INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
For primary bibliographic entry see Field 4C.
W89-06158

SOLUTE TRANSPORT THROUGH SMALL AND LARGE UNSATURATED COLUMNS,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 5B.
W89-06202

MODELING OF RETENTION OF ORGANIC CONTAMINANTS IN POROUS MEDIA OF UNIFORM SPHERICAL PARTICLES,
General Motors Research Labs., Warren, MI. Environmental Science Dept.
S. F. Kia.
Water Research WATRAG, Vol. 22, No. 10, p 1301-1309, October 1988. 9 fig, 25 ref, append.

Descriptors: *Path of pollutants, *Petroleum products, *Organic solvents, *Particle shape, *Soil contamination, *Oil spills, *Porous media, *Theoretical analysis, *Retention capacity, *Model studies, Capillary capacity, Porosity, Particle size, Pore size, Geometry.

In spill incidents of a contaminant, such as gasoline, a substantial fraction of the contaminant is retained within the pores of the unsaturated zone; this is defined as the residual or irreducible saturation. A theoretical model for the retention of organic contaminants in porous media is developed to predict the magnitude of the retention and to identify the parameters governing the retention process. The theoretical approach is based on the principles of capillary retention and is applied to porous media of equal spherical particles. The retention process is affected by system parameters such as wettability, particle size, and porosity. Moreover, retention is affected significantly by the pore geometry. These findings explain available experimental results that previously appeared conflicting with regard to the effect of parameters such as particle size and porosity on the retention. Depending on the medium pore geometry, the model predicts that the retention either increases or remains unaffected with a decrease in particle size. Also, over some ranges of medium porosity, the retention is predicted to increase with medium porosity, whereas the reverse trend is found over other ranges of porosity. The predicted trends of behavior for the retention are compared with available experimental results and a good agreement is observed. For a completely wetting fluid and over a wide range of porosity and particle size, the model predicts that the retention is generally in the range of 12-24% of pore volume. (Author's abstract)
W89-06227

TWO-DIMENSIONAL STEADY STATE UNSATURATED WATER FLOW IN HETEROGENEOUS SOILS WITH AUTOCORRELATED SOIL HYDRAULIC PROPERTIES,
Agricultural Univ., Wageningen (Netherlands). Dept. of Hydraulics and Catchment Hydrology.
J. W. Hopmans, H. Schukking, and P. J. F. Torfs.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2005-2017, December 1988. 5 tab, 7 fig, 33 ref.

Descriptors: *Soil water, *Soil saturation, Hydraulics, Pressure head, *Flow characteristics, *Unsaturated flow, Flow profiles, Autocorrelated properties, Two-dimensional flow, Stochastic process, Flow pattern, Flow system.

The stochastic nature of soil water pressure head and vertical and horizontal flux density under two-dimensional unsaturated steady state flow conditions was examined by using a Monte Carlo technique. Random autocorrelated scale factors were generated by a first-order nearest neighbor model and were used to describe a stationary random field of hydraulic conductivity functions. Scale factor values were assumed to vary only in the horizontal direction, perpendicular to the mean flow. The water flow equation was numerically solved for steady state infiltration and transpiration in a two-dimensional domain, of which the lower boundary was described by a groundwater level. Differences in results between a saturated and unsaturated soil water system were most likely caused by the direction in which the hydraulic properties are randomly autocorrelated and differences in the applied boundary conditions. In contrast to earlier findings with respect to the saturated system, the variability in fluxes for the unsaturated system decreased with an increase in the autocorrelation length, and the variation in soil water pressure head for one-dimensional and two-dimensional systems tended to be equal with increasing autocorrelation lengths. When considering a two-layer system it was found that the variability in the lateral flow component at the layer boundary was severely increased as compared to the single-layer simulations. (Author's abstract)
W89-06257

SECOND-ORDER KINETIC APPROACH FOR MODELING SOLUTE RETENTION AND TRANSPORT IN SOILS,
Louisiana State Univ., Baton Rouge.
For primary bibliographic entry see Field 5B.
W89-06261

EXTENT OF LATERAL WATER MOVEMENT IN THE SEDIMENTS OF A NEW ENGLAND SALT MARSH,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 2L.
W89-06262

CALCITE-CARBON EQUILIBRIUM IN SOIL WATER SAMPLES,
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
For primary bibliographic entry see Field 7B.
W89-06282

APPROACHES TO RAPID AND FAR-REACHING HYDROLOGIC PROCESSES IN THE VADOSE ZONE,
Rutgers - The State Univ., New Brunswick, NJ. Dept. of Soils and Crops.
For primary bibliographic entry see Field 2F.
W89-06421

AGGREGATED MIXING ZONE MODEL OF SOLUTE TRANSPORT THROUGH POROUS MEDIA,
Lancaster Univ. (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-06422

MODELING TRACER DIFFUSION IN FRACTURED AND UNFRACTURED, UNSATURATED, POROUS MEDIA,
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5B.
W89-06423

SUBSURFACE STORMFLOWS IN THE HIGHLY PERMEABLE FORESTED WATERSHEDS OF SOUTHWESTERN BRITISH COLUMBIA,
British Columbia Ministry of Forests and Lands, Kamloops. Research Section.
J. D. Cheng.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 171-191, December 1988. 7 fig, 6 tab, 52 ref.

Descriptors: *Rainfall-runoff relationships, *Path of pollutants, *Storm water, *Storm flow, *Subsurface water, *Storm seepage, *Forest watersheds, *Logging, *British Columbia, Hydrographs, Soil water, Conductivity, Flood peak, Erosion, Landslides, Logging, Rainstorms, Rainfall intensity, Land use, Nutrients.

Most forested watersheds in southwestern British Columbia are characterized by steep slopes, shallow but highly permeable soils and peak flows occurring mainly in the fall-winter period in response to major rainstorms with prolonged duration of 24 hours or greater. A comparison of rainfall intensities with soil hydrologic characteristics, hydrograph analyses and field observations strongly suggest that rapid subsurface flows through macropores and/or the soil matrix play a dominant role in contributing to stormflow volumes and peaks of forested watersheds in this coastal region. Two mechanisms observed in filed studies and considered to be at least partly responsible for the fast response of subsurface stormflows are (1) an effective flow delivery system associated with the expanding stream channels during a storm

and (2) the rapid transmission of flow through macropores with low resistance. The contribution to stormflow volume and magnitude from the 'new water' of current storms relative to that from the downslope displacement of the pre-storm 'old water', i.e. antecedent watershed moisture, requires close examination locally, but, as indicated by available electrical conductivity data, probably is positively related to the stormflow size. Implications of the study results are discussed with regard to peak flow estimation, landslide initiation, logging impact assessment and the movement of nutrients and contaminants. (Author's abstract)
W89-06424

CONTRIBUTIONS OF MACROPOROSITY TO INFILTRATION INTO A CONTINUOUS CORN NO-TILLED WATERSHED: IMPLICATIONS FOR CONTAMINANT MOVEMENT,
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
For primary bibliographic entry see Field 5B.
W89-06425

WETTING FRONT INSTABILITY AS A RAPID AND FAR-REACHING HYDROLOGIC PROCESS IN THE VADOSE ZONE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
R. J. Glass, T. S. Steenhuis, and J.-Y. Parlange.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 207-226, December 1988. 8 fig, 2 tab, 35 ref. Annual Allotment program of the OWRT, EPA grant R81-2919-01-0.

Descriptors: *Groundwater pollution, *Infiltration, *Solute transport, *Wetting, *Vadose water, *Soil water, *Infiltration, *Porosity, *Path of pollutants, Dyes, Tracers, Long Island, Sand, Porous media, New York.

Wetting front instability in the vadose zone causes the formation of fingers which can rapidly transport both water and solute to the phreatic surface. The development of the unstable flow field in laboratory experiments is described for an initially dry, two-layer sand system, in which the top layer has a finer texture than the bottom layer. The effect of repeated infiltration cycles and of initial moisture content at field capacity are presented. Fingers once formed in the dry porous media do not change location even after several infiltration events. Only saturation and subsequent drainage alters the finger structure within the chamber. In Eastern Long Island, New York, field infiltration experiments using the combination of two dyes showed that water moved through finger-like structures. (Author's abstract)
W89-06426

GEOSTATISTICAL ANALYSIS OF SOIL HYDROLOGIC PROPERTIES IN A FIELD PLOT,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
D. E. Greenholtz, T. C. J. Yeh, M. S. B. Nash, and P. J. Wierenga.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 227-250, December 1988. 6 fig, 6 tab, 29 ref. National Science Foundation grant CEE-8696060.

Descriptors: *Statistical methods, *Soil water, *Hydraulic conductivity, Spatial distribution, Temporal distribution, Water tension, Mathematical models, Pore size, Soil properties.

A 91-m transect was set up in an irrigated field near Las Cruces, N.M. to obtain soil water tension and water content data to investigate their spatial variability. Post-irrigation tension and wetness measurements were recorded over 45 days. Using the observed wetness and tension data, unsaturated hydraulic conductivity values were derived, and an exponential model was used to fit the calculated conductivity-tension curves to obtain hydraulic conductivity parameter values. The spatial and temporal variability of wetness, tension, saturated hydraulic conductivity and pore-size distribution parameters, and texture at the 0.3-m depth were examined using geostatistical techniques. The exponential model inadequately described the hydraulic conductivity/tension relationship for the full range of tension, particularly in the tension range near saturation. The derived values of the saturated hydraulic conductivity parameter were much greater than expected and do not correspond to reasonable saturated hydraulic conductivity values. All of the soil parameters studied exhibited large spatial variability horizontally and vertically in the field. Range of dependence determined from semivariogram analysis over the 44-day drainage period are 3-32 m for wetness, 6-34 for soil water tension, 5-35 m for natural log of saturated hydraulic conductivity parameters, 5-11 m for pore-size distribution parameter, and 8-24 for percent sand, silt and clay at the 0.3 depth. An alternate hole-effect model is suggested to describe the texture semivariograms. The variance of volumetric water content generally increased at each depth over the measured time periods, which is consistent with certain past field studies and a stochastic analysis of unsaturated flow in heterogeneous soils. Future research is recommended relating soil texture to soil hydrologic parameters with the goal of predicting soil behavior with less extensive sampling schemes. (Author's abstract)
W89-06427

KINEMATIC WAVE APPROXIMATION TO SOLUTE TRANSPORT ALONG PREFERRED FLOW PATHS IN SOILS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5B.
W89-06429

PRELIMINARY CAPILLARY HYSTERESIS SIMULATIONS IN FRACTURED ROCKS, YUCCA MOUNTAIN, NEVADA,
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W89-06430

SOURCE AREAS CONTRIBUTING TO THE EPISODIC ACIDIFICATION OF A FORESTED HEADWATER STREAM,
Pennsylvania State Univ., University Park. Forest Resources Lab.
For primary bibliographic entry see Field 5B.
W89-06431

TILE DRAIN SAMPLING OF PREFERENTIAL FLOW ON A FIELD SCALE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7B.
W89-06432

FLUX DENSITY AND BREAKTHROUGH TIMES FOR WATER AND TRACER IN A SPATIALLY VARIABLE, COMPACTED CLAY SOIL,
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W89-06433

MINLAKE: A DYNAMIC LAKE WATER QUALITY SIMULATION MODEL,
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
M. J. Riley, and H. G. Stefan.
Ecological Modelling ECMODT, Vol. 43, No. 3/4, p 155-182, November, 1988. 7 fig, 41 ref.

Descriptors: *Model studies, *Lakes, *Eutrophication, *Water quality, *Mathematical models, *Computer models, *Simulation, Stratification, Sediment-water interfaces, Solute transport, Water quality control, Nutrients.

A dynamic, one-dimensional unsteady lake water quality simulation model is described. The model is intended primarily for lake eutrophication studies and control strategies. The model attempts to simulate the continuous change of lake stratification and water quality in response to weather, inflow, outflow, exchange processes at the sediment interface and inlake processes. The latter include advective and diffusive transport, settling, chemical and biological kinetics. A Lagrangian approach is used for the simulation of transport processes. The model uses horizontal layers of time variable thickness. The water quality parameters modeled include temperature, up to three forms of algae (expresses as chlorophyll-a), several forms of phosphorus and nitrogen, detritus, zooplankton, inorganic suspended sediment and dissolved oxygen. The model simulates each parameter as a function of depth in 1-day timesteps. The model can be run on a personal computer. (Author's abstract)
W89-06452

SOIL COLUMN DESCRIPTIONS FROM X-RAY COMPUTED TOMOGRAPHY DENSITY IMAGES,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
For primary bibliographic entry see Field 7B.
W89-06482

EFFECT OF SAMPLE SIZE ON PARAMETER ESTIMATES IN SOLUTE-TRANSPORT EXPERIMENTS,
Agricultural Research Service, New Orleans, LA. Southern Regional Research Center.
R. C. Rice, and R. S. Bowman.
Soil Science SOSCAK, Vol. 146, No. 2, p 108-112, August 1988. 5 fig, 1 tab, 10 ref.

Descriptors: *Solute transport, *Sampling, Spatial distribution, Regression analysis, Hydrologic data collections, Leaching, Statistical methods, Bromides, Irrigation, Estimating, Ponding, Experimental design, Analysis of Variance.

The effect of sample size in determining parameters in solute transport experiments was investigated. Potassium bromide was uniformly applied to an 8 by 12-m plot and then ponded with a 100-mm irrigation. Twenty sites were sampled on a 1.8 by 2.5-m grid 6 days after irrigation. A 103-mm-diameter sample tube was inserted into the soil at 15-cm intervals. A 22-mm concentric subsample was obtained from the larger sample. The variances of the Br(-) concentration, water content, and total Br(-) recovery were not significantly different between the two sample sizes at the 0.05 significance level. The mean difference between the large and small samples was significantly different at the 0.1 level for Br(-) concentration and Br(-) recovery. The slope of the regression line was significantly different from 1 for Br(-) concentration only. Geostatistical structure analysis indicated that the variance of solute velocity using the large sample would only be about 3% smaller than that of the small sample. Although there was a significant bias toward the larger sample size for Br(-) concentration and recovery, spatial variability effects are far greater than sample size effects, and the Br(-) transport was adequately represented by the data collected using the small sample. The representative elementary volume was equaled or exceeded with the 22-mm diameter sample. (Author's abstract)
W89-06483

INTERMITTENT EVAPORATION, MOISTURE DISTRIBUTION, AND SALT REDISTRIBUTION THROUGH SALINE-SODIC CLAY SOIL AS AFFECTED BY IRRIGATION FREQUENCY AND QUANTITY,
Khartoum Univ. (Sudan). Dept. of Agricultural Engineering and Soil Science.
For primary bibliographic entry see Field 2D.
W89-06484

BIOGEOCHEMISTRY OF TWO APPALACHIAN DECIDUOUS FOREST SITES IN RELATION TO EPISODIC STREAM ACIDIFICATION,
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 5B.
W89-06488

ADSORPTION-DESORPTION OF ATRAZINE ON FOUR SOILS OF HYDERABAD,
Andhra Pradesh Agricultural Univ., Hyderabad (India).
For primary bibliographic entry see Field 5B.
W89-06490

APPLICATION OF GEOPHYSICAL METHODS IN DESCRIBING SPATIAL VARIABILITY OF SATURATED HYDRAULIC CONDUCTIVITY IN THE ZONE OF AERATION,
Geofyzika, n.p., Brno (Czechoslovakia).
For primary bibliographic entry see Field 2F.
W89-06515

UNSATURATED SEEPAGE AND SUBTERRANEAN HOLES: CONSPECTUS, AND EXCLUSION PROBLEM FOR CIRCULAR CYLINDRICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2F.
W89-06576

SEEPAGE EXCLUSION PROBLEM FOR SPHERICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2F.
W89-06577

SOLUTE AND WATER MOVEMENT IN UNSATURATED SOILS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 5B.
W89-06578

EFFICIENT FINITE ELEMENT METHOD FOR MODELING MULTIPHASE FLOW,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
For primary bibliographic entry see Field 5B.
W89-06579

UNSATURATED VERTICAL FLOWS ABOVE A WATER TABLE,
Department of Scientific and Industrial Research, Wellington (New Zealand). Applied Mathematics Div.
G. J. Weir.
Water Resources Research WRERAO, Vol. 25, No. 1, p 55-60, January 1989. 3 fig, 1 tab, 11 ref, 3 append.

Descriptors: *Infiltration, *Recharge, *Vertical flow, *Unsaturated flow, *Vadose water, *Hydraulic conductivity, Mathematical studies, Saturation, Water table, Infiltration rate.

An effective conductivity (resistance) for unsaturated vertical flow through horizontal layers of quasi-linear material above a water table was determined by summing 'saturated' resistances in series, subject to an exponential weighting with depth. These effective conductivities essentially determine steady flows, while calculation of intercepts involve weighting changes in water saturation with effective conductivities (resistances) and an exponential function of depth. Exact expressions were determined for the intercept associated with changes in surface values of saturation, and for instantaneous rises in the water table, in a Davidson model soil. (Author's abstract)
W89-06580

OBSERVATIONS OF WATER AND OIL INFILTRATION INTO SOIL: SOME SIMULATION CHALLENGES,
Battelle Pacific Northwest Labs., Richland, WA. Geosciences Dept.
For primary bibliographic entry see Field 5B.
W89-06582

CRITICAL EVALUATION OF RECENT DEVELOPMENTS IN HYDROGEOCHEMICAL TRANSPORT MODELS OF REACTIVE MULTICHEMICAL COMPONENTS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 7C.
W89-06584

MULTIDIMENSIONAL STEADY INFILTRATION TO A WATER TABLE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
J. R. Philip.
Water Resources Research WRERAO, Vol. 25, No. 1, p 109-116, January 1989. 5 fig, 2 tab, 26 ref.

Descriptors: *Infiltration, *Recharge, *Model studies, *Groundwater movement, *Drainage, *Subsurface drainage, *Mathematical analysis, Mathematical models, Steady flow, Water table.

The applicability of the body of solutions for quasi-linear multidimensional steady infiltrations with perfect drainage to cases with a water table (or, by inference, a sloping impermeable base) at finite depth beneath the water supply source is considered. The exact solutions for steady quasi-linear point and line sources over a water table are the point of departure. With their aid approximate solutions were constructed to the general problem of three-dimensional axisymmetric and two-dimensional steady infiltration from finite water supply sources at fixed moisture potential to a water table at finite depth. Disc- and strip-shaped water supply sources are used as illustrative solutions. When the depth from the source to the water table (or the base) is of order 4 sorptive lengths, perfect drainage solutions yield discharge estimates of ample accuracy. When the depth is less, the approximate analysis gives, in favorable cases, the requisite correction. In less favorable cases it gives the order of magnitude of the correction. The study was facilitated by a method of exponentially weighted images, applicable to the quasi-linear flow equation. (Author's abstract)
W89-06585

PLANT-SOIL-WATER RELATIONSHIPS IN LAS VEGAS WASH,
Bureau of Reclamation, Boulder City, NV. Lower Colorado Region.
J. M. Jackson, and D. T. Patten.
Available from National Technical Information Service, Springfield, VA 22161, PB89-110761. Price codes: A03 in paper copy, A01 in microfiche. Report No. REC-ERC-88-4, February 1988. 30p, 16 fig, 7 tab, 66 ref, append.

Descriptors: *Soil-water-plant relationships, *Nevada, *Wetlands, Las Vegas, Reeds, Wetlands, Groundwater, Groundwater quality, Environmental effects, Soil contamination, Cattails, Salinity, Brackish waters, Saline soils.

The Las Vegas Wash in Clark County, Nevada, is the primary drainage for 4,144 sq km of the Las Vegas Valley. The Wash supports over 1,200 ha of cattail, common reed, and salt cedar. Water supply to this unique, arid zone, brackish water wetland is by regional groundwater drainage, sewage treatment plant discharge, and urban runoff. The relationships between plant community distribution and environmental quality were examined during a study conducted from May 1986 through April 1987. Data were collected from 71 sites on vegetation, water table fluctuations, groundwater quality, and soil quality. Community species composition and stand vigor were correlated with seasonal depth to groundwater and soil salinity. Cattails were closely associated with sites of high moisture and low salinity. Reed sites were slightly drier and more saline than cattail sites, while salt cedar sites exhibited the driest and most saline conditions. Soil quality appeared to be a function of both groundwater quality and water table fluctuations. The differences in soil salinity among vegetation types were very pronounced in the fall, which probably represented the driest and most saline period. (Author's abstract)
W89-06624

PHYSICS OF IMMISCIBLE FLOW IN POROUS MEDIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 5B.
W89-06658

GOVERNING PARTIAL DIFFERENTIAL EQUATION FOR ONE-DIMENSIONAL FLOW OF WATER IN A DEFORMING BODY OF SOIL,
Nebraska Univ.-Lincoln.
O. W. Baumer.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8706222. Ph.D. Dissertation, 1986. 100p, 5 fig, 6 tab, 22 ref, 2 append.

Descriptors: *Flow characteristics, *Groundwater movement, *Mass wasting, *Soil water, *Mathematical analysis, *Differential equations, Darcys Law, Deformation, Flow discharge.

For the formulation of the problem of the flow of water through a deforming body of soil, a partial differential equation in the spatial (Eulerian) coordinate system is derived. The system is a fixed, stationary frame of reference that describes the one-dimensionally non-homogeneous, deforming body of soil that consists of solids, water and gas. It is assumed that cross sectional areas remain constant throughout the soil, the soil volume deforms in time in response to a change in water content, and as the volume deforms each cross section remains plane throughout the motion and moves longitudinally without distortion. Proof is offered that for a given location the ratio of the volume fraction of the soil solids at a reference time to the volume fraction of the soil solids at a given time is equal to the Jacobian at that given location at that given time. A general partial integrodifferential equation for the one-dimensional velocity of the soil solids is derived. The correct use of Darcy's law as it applies to the flow of water relative to the solids is demonstrated. Some simple approaches for the solution of the governing partial differential equation are discussed. (Cremmins-AEPCO)
W89-06956

2H. Lakes

NOVEL METHOD FOR STUDYING PLASMID TRANSFER IN UNDISTURBED RIVER EPILITHON,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
M. J. Bale, M. J. Day, and J. C. Fry.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2756-2758, November 1988. 2 tab, 10 ref.

Descriptors: *Stream biota, *In situ studies, *Plasmid transfer, *Bacterial physiology, Bacteria, Rivers, Heterotrophic bacteria, Mercury, Heavy metals, Culture media, Physiological ecology, Pseudomonas.

A method for in situ bacterial mating experiments is described which involved overnight incorporation of donors containing the mercury resistance plasmid pQM1 and recipients into the epilithon on separate river stones. The stones were then joined and secured with elastic bands to begin the mating. Transfer frequencies obtained were between 0.22 and 0.0000025 per recipient and appeared to depend on the donor-to-recipient ratio and not on the river temperature. Controls showed that the low density of donors and recipients at the end of the experiment did not significantly affect the heterotrophic bacterial count nor the fluorescent-pseudomonad count. (Author's abstract) 35 065278001
W89-05794

SIMULTANEOUS NITRIFICATION AND DENITRIFICATION IN AEROBIC CHEMOSTAT CULTURES OF THIOSPHAERA PANTOTROPHA,

Technische Hogeschool Delft (Netherlands). Lab. of Microbiology and Enzymology.
L. A. Robertson, E. W. J. van Niel, R. A. M. Torremans, and J. G. Kuenen.

Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2812-2818, November 1988. 3 fig, 5 tab, 31 ref.

Descriptors: *Nitrification, *Denitrification, *Thiosphaera, *Bacterial physiology, *Heterotrophic bacteria, *Aerobic conditions, *Culture media, Anaerobic conditions, Biomass, Nitrites, Metabolism, Nitrates, Sulfates, Culture media, Oxygen, Dissolved oxygen, Energy, Bacteria, Microbiological studies.

Thiosphaera pantotropha is capable of simultaneous heterotrophic nitrification and aerobic denitrification. The nitrification rate could be reduced by the provision of nitrate, nitrite, or thiosulfate to the culture medium. Both nitrification and denitrification increased as the dissolved oxygen concentration fell, until a critical level was reached at approximately 25% of air saturation. At this point, the rate of (aerobic) denitrification was equivalent to the anaerobic rate. At this dissolved oxygen concentration, the combined nitrification and denitrification was such that cultures receiving ammonium as their sole source of nitrogen appeared to become oxygen limited and the nitrification rate fell. It appeared that, under carbon-limited and energy-limited conditions, a high nitrification rate was correlated with a reduced biomass yield. To facilitate experimental design, a working hypothesis for the mechanism behind nitrification and denitrification by T. pantotropha was formulated. This involved the basic assumption that this species has a 'bottleneck' in its cytochrome chain to oxygen and that denitrification and nitrification are used to overcome this. The nitrification potential of other heterotrophic nitrifiers has been reconsidered. Several species considered to be 'poor' nitrifiers also simultaneously nitrify and denitrify, thus giving a falsely low nitrification potential. (Author's abstract)
W89-05798

ROLE OF SUBLETHAL INJURY IN DECLINE OF BACTERIAL POPULATIONS IN LAKE WATER,

Cornell Univ., Ithaca, NY. Lab. of Soil Microbiology.
For primary bibliographic entry see Field 5B.
W89-05800

AQUATIC HETEROTROPHIC BACTERIA: MODELING IN THE PRESENCE OF SPATIAL AUTOCORRELATION,

Montreal Univ. (Quebec). Dept. of Biological Sciences.
P. Legendre, and M. Troussellier.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1055-1067, September 1988. 6 fig, 4 tab, 45 ref. NSERC Grant A7738.

Descriptors: *Correlation analysis, *Estuarine environment, *Limnology, *Spatial distribution, *Aquatic bacteria, *Heterotrophic bacteria, *Model studies, Phytoplankton, Physiological ecology, Bacteria, Microbiological studies, Statistical methods, Ecology, Aquatic plants, Plankton, Culture media, Organic matter, Particulate matter, Biomass, Chlorophyll A, Distribution, Brackish water.

Methods are described for exploring the spatial structure of ecological data and including spatial location as a variable in the study of relationships and models. The relationship between environmental heterotrophic bacteria and phytoplankton, well established in aquatic environments, is re-examined in the Thau brackish lagoon (Mediterranean coast of France). It did not hold for the bacteria growing on bioMerieux nutrient agar (BNA), which are presumably of continental origin; their spatial gradient can only partly be explained by the particulate organic carbon variable (POC) and not at all by phytoplankton biomass (CHL A), despite the existence of a spurious correlation between BNA and CHL A. The spatial gradient of abundance of heterotrophs growing on marine agar (MA), expected to be mostly of marine origin, can be entirely explained by POC and CHL A. Different segments of the bacterial community, both reacting positively to variations of the particulate organic carbon, may follow partly, or not, variations of phytoplankton biomass. The mode of analysis developed here extends to many other spatially distributed processes in ecology and other fields. (Author's abstract)
W89-05801

CONVECTIVE CIRCULATION IN LITTORAL WATER DUE TO SURFACE COOLING,

Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
G. M. Horsch, and H. G. Stefan.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1068-1083, September 1988. 10 fig, 1 tab, 25 ref.

Descriptors: *Water circulation, *Surface water, *Convection, *Littoral zone, *Cooling, *Lakes, *Model studies, *Limnology, Zones, Water temperature, Physical properties, Heat flow, Numerical analysis, Simulation, Mathematical models, Model testing, Limnology, Flow resistance.

Cooling of littoral waters of a lake under calm conditions creates a horizontal temperature gradient because surface heat loss is distributed over progressively larger depth by plunging sheets (thermals). Resulting convective circulation establishes an exchange flow between littoral and open waters. Numerical simulations illustrate the development of the flow from the formation of thermals to the establishment of a horizontal circulation. Circulation flow rate was found to be proportional to the Rayleigh number for values in the range 10,000 to 10 to the 8th power. A laboratory visualization experiment at a Rayleigh number of 10 to the 9th power confirmed the main features of the simulation. To consider applications to vegetated littoral slopes, the results were interpreted with a formula accounting for the added resistance offered to the flow by the aquatic plants. An example showed that convective circulation can be a significant factor in renewing littoral waters. (Author's abstract)
W89-05802

SIMPLE MODEL FOR PREDICTING THE DATE OF FALL TURNOVER IN THERMALLY STRATIFIED LAKES,

Ontario Ministry of the Environment, Dorchester. Dorset Research Center.
G. N. Nurnberg.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1190-1195, September 1988. 5 fig, 3 tab, 14 ref.

Descriptors: *Limnology, *Model studies, *Turnover time, *Thermal stratification, *Lakes, Heat budget, Stratification, Hypolimnion, Water temperature, Physical properties, Limnology, Acidity, Water depth, Monitoring, Cooling, Diversion, Dam effects.

A model for predicting fall turnover date in thermally stratified lakes using easily obtainable characteristics is presented. Data were drawn from lakes of a single region in southern Ontario, from lakes across North America and Europe (from the literature), and from acid lakes near Sudbury, Ontario. It was found that the date of fall turnover can be predicted from average midsummer hypolimnetic temperature in acidic and non-acidic lakes in central Ontario. The prediction of fall turnover date is improved by inclusion of two further independent variables, mean depth (z) and adjusted latitude (for altitude), in a global data set (ranges of z, 1.1-86 m; adjusted latitude, 38-65 deg). The models explain 67-80% of the variance of fall turnover date and are potentially useful in the design of monitoring programs and for predicting impacts of anthropogenic activities that influence lake thermal budgets, e.g., diversion for cooling waters or damming of cold inflows. (Author's abstract)
W89-05806

INTERACTIONS OF INORGANIC CARBON AND LIGHT AVAILABILITY AS CONTROLLING FACTORS IN AQUATIC MACROPHYTE DISTRIBUTION AND PRODUCTIVITY,

Wayne State Univ., Detroit, MI. Dept. of Biological Sciences.
R. A. Hough, and M. D. Fornwall.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1202-1208, September 1988. 7 fig, 1 tab, 29 ref. NSF Grants DEB 76-04502 and DEB 81-03528.

Descriptors: *Limnology, *Nutrients, *Carbon, *Light penetration, *Distribution patterns, *Productivity, *Macrophytes, *Aquatic plants, Photosynthesis, Submerged plants, Lakes, Acidity, Flow, Turbidity, Physical properties, Bicarbonates, Carbon dioxide, Alkalinity, Sago pondweed.

The roles of inorganic carbon and light availability in the quantitative distribution and photosynthetic productivity of submersed aquatic macrophytes were investigated in two lakes in a stream-connected hard-water lake chain where light availability and pH increase and total inorganic carbon decreases as water flows from a turbid productive lake through progressively clearer less productive lakes. Bicarbonate-using species dominated the macrophyte communities of both lakes, but species requiring free CO2 were present, primarily in the more turbid lake. In photosynthesis experiments, CO2-requirer Najas flexilis was significantly competitive when light limitation reduced the efficiency of HCO3(-)-user Potamogeton pectinatus. The results suggest that inorganic carbon availability can be important in macrophyte growth even within relatively small ranges of total alkalinity and that light availability is a potentially important interacting factor. (Author's abstract)
W89-05807

EVALUATION OF FACTORS CONTRIBUTING TO DIURNAL CHANGES IN O2 CONCENTRATIONS IN FLOODWATER OF DEEPWATER RICE FIELDS,

Western Australia Univ., Nedlands. Inst. of Agriculture.
T. L. Setter, T. Kupkanchanakul, I. Waters, and H. Greenway.
New Phytologist NEPHAV, Vol. 110, No. 2, p 151-162, October 1988. 6 fig, 2 tab, 19 ref, 2 append.

Descriptors: *Oxygen balance, *Rice, *Floodwater, *Crop production, Diurnal distribution, Wind, Cooling, Evaporation, Eddies, Water currents, Photosynthesis, Biomass, Oxygen requirements, Flow, Leaves, Canopy, Air-water interfaces, Respiration.

Glass chambers were used to isolate 0.75 m deep water columns in situ in deepwater rice fields in Thailand to evaluate the contribution of various factors to the pronounced diurnal changes in oxygen concentrations in the floodwater. Factors studied include eddy currents associated with wind action and evaporative cooling, oxygen evolution due to photosynthesis, and canopy effects on oxygen movement from the air into the aquatic part of the ecosystem. The changes in oxygen concentration were analyzed quantitatively using several simplifying assumptions. One major input was a net oxygen flow from the air into the water, about half being due to a net flow across the air-water interface and the other half to flow associated with the rice plants. During the night, these flows were less than the oxygen uptake by the biomass, hence oxygen concentrations decreased. In the underwater portion of the rice stand, about 60% of the oxygen uptake was due to the rice and about 40% due to the biomass other than rice. During the day, the oxygen requirements by respiration were more than compensated for by oxygen evolution due to photosynthesis, resulting in increases in oxygen concentration of the water. (Author's abstract)
W89-05812

DETERMINISTIC MODELLING OF VERTICAL CIRCULATION IN SHALLOW LAKES AND RESERVOIRS,
Bradford Univ. (England). Dept. of Civil Engineering and Structural Engineering.
R. A. Falconer, and I. C. S. Cox.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 5, p 583-596, November-December 1988. 8 fig, 1 tab, 23 ref.

Descriptors: *Reservoirs, *Lakes, *Water circulation, *Mathematical models, *Wind-driven currents, *Reservoir operations, Mathematical equations, Friction, Shear stress, Turbulent mixing, Comparison studies, England, Shustoke Reservoir, Esthwaite Water.

A two-dimensional breadth-averaged deterministic mathematical model was developed to determine the wind-induced vertical circulation and mixing in shallow lakes or impoundments. Such models are increasingly being used by water engineers and scientists so that water supply lakes and reservoirs can be managed and operated more efficiently, particularly in connection with environmental and ecological considerations. The present model includes a solution of the two-dimensional form of the mass and momentum conservation equations, with particular emphasis being placed on the inclusion and representation of the bed friction, wind shear stress, and the turbulent mixing process. The pressure field was determined from the depth-averaged form of the governing differential equations, with the complete set of equations being expressed in an implicit finite difference form for solution. Results from the model were compared with analytical solutions for two idealized flow fields, with good agreement being obtained between both sets of results. Simulations of wind-induced circulation were performed for two reservoirs (Shustoke Reservoir, near Birmingham, England, and Esthwaite Water, near Windermere, England). The results obtained were in keeping with the published results of other researchers. (Author's abstract)
W89-05838

INFLUENCE OF REGULATION ON ENVIRONMENTAL CONDITIONS AND THE MACROINVERTEBRATE COMMUNITY IN THE UPPER COLORADO RIVER,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 6G.
W89-05839

ASSESSMENT OF THE WATER SURFACE PROFILE MODEL: ACCURACY OF PREDICTED INSTREAM FISH HABITAT CONDITIONS IN LOW-GRADIENT, WARMWATER STREAMS,
Illinois Natural History Survey, Champaign.
L. L. Osborne, M. J. Wiley, and R. W. Larimore.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 5, p 619-631, November-December 1988. 6 tab, 27 ref. Illinois Department of Conservation and U.S. Fish and Wildlife Service Federal Aid Project F-43-R.

Descriptors: *Flow characteristics, *Hydraulic models, *Water Surface Profile Model, *Fish, *Aquatic habitats, Incremental methodology, Performance evaluation, Illinois, Mathematical models, PHABSIM Model, Warmwater streams, Weighted Usable Area, Incremental methodology.

The Instream Flow Group's (U.S. Fish and Wildlife Service) Physical Habitat Simulation (PHABSIM) model, the major component of the incremental methodology (IFMIM) is the most widely used instream flow assessment procedure. The Water Surface Profile (WSP) hydrologic model commonly is recommended and employed in many PHABSIM applications. The effects of errors in the WSP hydrologic simulation on the final PHABSIM output (i.e., weighted usable area (WUA) estimates) has been little studied. A study was conducted to examine the effectiveness of the WSP hydraulic model for predicting hydraulic conditions in low-gradient, warmwater streams in east-central Illinois. Attempts were made to calibrate the WSP model at four locations on the Salt Fork and Middle Fork Rivers and to compare the simulated results to actual measured conditions at different discharges. It is concluded that, in low-gradient streams, the WSP model: (1) does not adequately simulate low-flow habitat conditions, due to an inability to calibrate the model; (2) is, at best, difficult to calibrate, even within hydraulically uniform channels; (3) requires several field measurements and calibrations to simulate a sufficiently wide range of naturally occurring flows; (4) provides poor estimates of cell depth and velocity; and (5) results in highly erratic and often poor estimates of WUA for adults and fry of smallmouth bass. Similar or better estimates of actual WUA can be obtained by monitoring the distributions of depth, velocity, and substrate at a series of representative transects at different discharges and interpolating WUA from observed field data using less expensive and time-consuming regression models. (Author's abstract)
W89-05840

EVAPORATION FROM LAKE BIWA,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2D.
W89-05862

BLUFF RESPONSE TO WAVE ACTION,
Pittsburgh Univ., PA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W89-05919

MIGRATION OF TECHNETIUM, IODINE, NEPTUNIUM, AND URANIUM IN THE PEAT OF TWO MINEROTROPHIC MIRES,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Environmental Research Branch.
For primary bibliographic entry see Field 5B.
W89-05936

PILOT-SCALE EVALUATION OF ALUM TREATMENTS TO REDUCE LAKE SEDIMENT PHOSPHORUS RELEASE,
Clarkson Coll. of Technology, Potsdam, NY. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-05939

STREAMFLOW NUTRIENT DYNAMICS ON COASTAL PLAIN WATERSHEDS,
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
For primary bibliographic entry see Field 5B.
W89-05942

UPTAKE AND ACCUMULATION OF INORGANIC CARBON BY A FRESHWATER DIATOM,
York Univ., Downsview (Ontario). Dept. of Biology.
B. Colman, and C. Rotatore.
Journal of Experimental Botany JEBOA6, Vol. 39, No. 205, p 1025-1032, August 1988. 3 fig, 2 tab, 22 ref.

Descriptors: *Absorption, *Nutrient uptake, *Inorganic compounds, *Accumulation, *Diatoms, Navicula, *Carbon, Carbon dioxide, Photosynthesis, Hydrogen ion concentration, Oxygen, Bicarbonates.

The mechanism of uptake of inorganic carbon and its accumulation was studied in the freshwater diatom Navicula pelliculosa. No external carbonic anhydrase could be detected, although it was detected in cell extracts. The rate of photosynthetic O2 evolution, in media in the range pH 7.5 to 8.5, exceeded the calculated rate of CO2 supply 2-fold to 5-fold, indicating that HCO3(-) was taken up by the cells. At an external pH of 7.5, the internal pH, measured by 14C-dimethyloxazolidine-2,4-dione distribution between the cells and the medium, was pH 7.6 in the light and pH 7.4 in the dark. Accumulation of inorganic carbon was determined by the silicone oil centrifugation method and inorganic carbon pools of 23.5 mol per cu m were found, a concentration 21.6-fold that in the external medium. The results indicate an active accumulation of inorganic carbon against pH and concentration gradients in this diatom, probably by active HCO3(-) uptake. (Author's abstract)
W89-05946

PERSISTENCE OF HEXAZINONE (VELPAR), TRICLOPYR (GARLON), AND 2,4-D IN A NORTHERN ONTARIO AQUATIC ENVIRONMENT,
Canadian Centre for Toxicology, Guelph (Ontario).
For primary bibliographic entry see Field 5B.
W89-05948

PLASMIDS IN THE BACTERIAL ASSEMBLAGE OF A DYSTROPHIC LAKE: EVIDENCE FOR PLASMID-ENCODED NICKEL RESISTANCE,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
For primary bibliographic entry see Field 5C.
W89-05967

FLOODPLAIN VEGETATION OF THE IBI RIVER IN CENTRAL JAPAN: I. DISTRIBUTION BEHAVIOR AND HABITAT CONDITIONS OF THE MAIN SPECIES OF THE RIVER BED VEGETATION DEVELOPING ON THE ALLUVIAL FAN, ENGLISH SUMMARY.
Kochi Univ. (Japan). Dept. of Biology.
S. Ishikawa.
Japanese Journal of Ecology JJECDN, Vol. 38, No. 2, p 73-84, August 1988. 6 fig, 1 tab, 24 ref.

Descriptors: *Floodplains, *Ibi River, *Japan, *Vegetation, *River beds, *Alluvial fans, Species distribution, Distribution, Habitats, Sediments.

The floodplain vegetation of the Ibi River (central Japan) was investigated from its source to its mouth. Four major vegetational area, which are developing on the floodplain were recognized: (1) the mountain region, (2) the alluvial fan, (3) the natural levee region, and (4) the deltaic plain. The habitat conditions of 12 main species growing on the river bed of the alluvial fan were elucidated in relation to the relative height above water level and the grain size distributions of sediments. The relative height and the mean grain size of the habitats dominated by these 12 main species were: (1) Miscanthus sinensis and Pueraria lobata, high medium and coarse fine, (2) Imperata cylindrica var. koenigii, high medium and fine medium, (3) Lespedeza cuneata, high medium and coarse fine, (4) Anaphalis margaritacea subsp. yedoensis and Oenothera biennis, medium and coarse, (5) Artemisia princeps, high-low and coarse-fine, (6) Salix gracilistyla, medium-low and coarse-medium, (7) Salix gilgiana, medium-low and medium-fine, (8) Salix chaenomeloides, low and medium-fine, (9) Phragmites japonica, low and coarse-fine, and (10) Polygonum hydropiper, low and coarse medium. The standard deviation and the kurtosis of sediments were available for the comparative study between stands having similar mean values of sediments. (Author's abstract)
W89-05969

HISTORICAL AND RECENT DATA OF THE WATER CHEMISTRY AND PHYTOPLANKTON IN THE RIJNLAND AREA,
Hoogheemraadschap van Rijnland, Leiden (Netherlands).
For primary bibliographic entry see Field 5B.
W89-05989

PHYTOPLANKTON DEATH AND NITRIFICATION AT LOW TEMPERATURES,
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
Y. Collos, E. A. S. Linley, M. G. Frikha, and B. Ravail.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 8, No. 6, p 341-347, September 1988. 4 fig, 1 tab, 26 ref.

Descriptors: *Mortality, *Wetlands, *Tidal wetlands, *Phytoplankton, *Nitrification, Nitrogen cycle, Ponds, Temperature effects, Decay, Biomass, Population dynamics, Seawater.

A close link between the crash of a phytoplankton community and simultaneous nitrification as measured by net change in nitrate is described. An extremely tight coupling was found between microalgal biomass decreases and nitrification in a shallow dirt pond filled with coastal seawater after a spring tide. Degradation of half of the phytoplankton standing crop and transformation into dissolved nitrate occurred within 2-3 days without accumulation of intermediate compounds such as ammonium or nitrate. The event time scale was of the order of one week, starting with a sub-zero water temperature, followed by a two-fold decrease in chlorophyll-a and particulate nitrogen and a simultaneous two-fold increase in nitrate over 48 h, and ending with recovery of the phytoplankton population within five days. A second event then started with a new period of cold weather. These mesocosm events were duplicated in a 2-l microcosm, showing that nitrification had taken place in the water column for the most part, and can proceed at sub-zero temperatures very efficiently. (Author's abstract)
W89-05994

LONGITUDINAL AND VERTICAL CHANGES IN LAKE ESTUARINE SEDIMENTS,
National Inst. for Environmental Studies, Tsukuba (Japan).
For primary bibliographic entry see Field 2J.
W89-06029

EFFECT OF SALINITY ON NITRIFICATION IN A TIDAL RIVER,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
H. Furumai, T. Kawasaki, T. Futawatari, and T. Kusuda.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 165-174, 1988. 12 fig, 3 tab, 15 ref.

Descriptors: *Salinity, *Nitrification, *Tidal rivers, *Suspended solids, *Water quality, *Fate of pollutants, Turbidity, Nitrates, Bacteria, Field tests, Nitrogen, Growth kinetics, Seasonal variation, Nitrites, Ammonium, Model studies, Oxygen.

Several field surveys were conducted to investigate changes of water quality with time in the tidal River Rokkaku, where a turbidity maximum exists. Suspended solids of the turbidity maximum reach more than 20 g/L in concentration. Based on the surveys, NH4-N, NO2-N, and NO3-N have peaks in concentration at certain salinities, located in order of NH4-N, NO2-N, and NO3-N toward the river mouth within 10 to 25 km from it. The salinities were 0.5, 1.7, and 3.0 parts per thousand (ppt), respectively, and the maximum concentrations were about 3.0, 0.3, and 4.5 mg/L in winter time, respectively. Laboratory batch experiments were conducted, using suspended solids and sediments taken from the river, to study the effect of salinity on nitrification and to estimate kinetics parameters of it in the river. Suspended solids and sediments were sampled at a point in the middle stream. The sediments were collected from the aerobic layer of mud, less than 1 cm thick from the surface. Experimental results indicated much more inhibition of NO2 oxidation by salinity than that of NH4 oxidation. Nitrifying bacteria in sediments were less sensitive to salinity than those in suspended solids. The change of nitrogen concentration with time was clearly explained with the Monod growth model and the two kinetics parameters were obtained by the curve fitting method. Maximum specific growth rates of NH4 oxidizing bacteria ranged from 0.015 to 0.029 per hour, which decreased markedly with more than 15 ppt salinity. Those of NO2 oxidizing bacteria ranged from 0.015 to 0.025 per hour. Saturation constants of NH4 and NO2 oxidation were also dependent on salinity. Changes in NH4-N and NO2-N concentrations in the River Rokkaku with time were simulated well using a newly developed river model and the parameter values obtained in the laboratory tests. The mechanism of nitrification by suspended solids and sediments in the river is shown to depend on tidal effects. (Author's abstract)
W89-06031

FIELD OBSERVATION AND SIMULATION OF SEDIMENT RESUSPENSION IN A SHALLOW LAKE,
National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div.
For primary bibliographic entry see Field 2J.
W89-06042

USE OF IN SITU MICROCOSMS FOR EVALUATING RESERVOIR WATER MANAGEMENT OPTIONS,
Nevada Univ. System, Las Vegas. Water Resources Center.
For primary bibliographic entry see Field 7B.
W89-06056

ESTIMATES OF MEAN CHLOROPHYLL-A CONCENTRATION: PRECISION, ACCURACY, AND SAMPLING DESIGN,
McGill Univ., Montreal (Quebec). Dept. of Biology.
For primary bibliographic entry see Field 7B.
W89-06058

FUNDAMENTAL INVESTIGATION OF GRAVITY CURRENTS WITH VARYING DENSITY,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
J. J. Warwick, and W. A. Murray.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1041-1047, October 1988. 1 tab, 6 fig, 7 ref.

Descriptors: *Gravity flow, *Density currents, *Flow characteristics, *Reservoirs, *Mathematical models, Non-uniform flow, Underflow, Flow profiles, Fluid flow.

A one-dimensional, gradually varying, non-uniform, flow equation was developed to describe the movement of a variable density gravity current through a reservoir. A linearly decreasing underflow density function was used to investigate the effect of in-reservoir density reduction on typical gravity current flow profiles. Only two types of flow profiles were found to exist for varying density underflows: Type I profiles where the underflow asymptotically approaches a horizontal surface, and Type III profiles where the underflow vertically approaches critical depth. Type I profiles pass through a transitional depth as the underflow density approaches that of the upper layer. Results indicate that a reservoir can be segmented into four distinct spatial regions with well defined flow profile characteristics. The location of these regions allows the sketching of interfacial flow profiles along with identifying the location of transitional depth conditions. Transitional depth conditions are utilized as the logical starting point for Type I flow profile numerical computation. (Author's abstract)
W89-06060

BLUE-GREEN ALGAE IN LAKE BIWA WHICH PRODUCE EARTHY-MUSTY ODORS,
Kyoto Municipal Water Works Bureau (Japan). Water Quality Lab.
For primary bibliographic entry see Field 5B.
W89-06116

MUSTY ODOUR PROBLEMS IN LAKE BIWA 1982-1987,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
For primary bibliographic entry see Field 5B.
W89-06118

EARTHY-MUSTY ODOR-PRODUCING CYANOPHYTES ISOLATED FROM FIVE WATER AREAS IN TOKYO,
Tokyo Metropolitan Research Lab. of Public Health (Japan).
For primary bibliographic entry see Field 5B.
W89-06124

NITROGEN AND THE THRESHOLD ODOR NUMBER PRODUCED BY AN ACTINOMYCETE ISOLATED FROM LAKE SEDIMENTS,
Baylor Univ., Waco, TX. Dept. of Biology.
For primary bibliographic entry see Field 5B.
W89-06125

POST-GLACIAL SEDIMENTS AND THE STAGNATION HISTORY OF THE IRON-MEROMICTIC LAKE SKJENNUNGEN, EASTERN NORWAY,
Oslo Univ. (Norway). Dept. of Limnology.
J. Kjensmo.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 481-499, 7 fig, 3 tab, 32 ref.

Descriptors: *Paleolimnology, *Lake sediments, *Organic matter, *Norway, *Lakes, *Limnology, Silt, Sedimentology, Meromixis, Iron, Calcium, Sodium, Manganese, Nitrogen, Chlorophyll, Radioactive dating, Sedimentation rates, Core logging, Potassium, Phosphorus.

The total thickness of the sediments accumulated over the deepest area of Lake Skjennungen since Fini-glacial time amounted to 280 cm. Except for a 20 cm thick layer of glacial silt covering the rock bed of the basin, allochthonous organic sediments represented the uppermost 260 cm, i.e. a period of ca. 8000 years of the lake's history. The parent rocks for the glacial silt were the Permian plutonics of the Nordmarka area, a fact which was clearly demonstrated by the content of major inorganic constituents in the silt. Very small amounts of the latter constituents were present in the uppermost 260 cm of organic dominated sediments. Amorphous silica and exchangeable calcium and exchangeable sodium dominated the concentration of these three elements in the latter sediments. Changes in the concentrations of the redox sensitive elements iron, manganese, and nitrogen together with changing concentrations of chlorophyll derivatives and of amorphous silica, all the changes occurring at ca. 60 cm depth in the sediments, pointed out that depth for the initiation of meromixis in Lake Skjennungen. The sediments at 60 cm depth were radio-carbon dated to 1520 +/- 110 years B.P. Accordingly, due to accumulation of great amounts of ferrous bicarbonate in the deep waters occurring ca. 1500 years B.P. a meromictic stability was initiated in the lake. (Author's abstract)
W89-06139

SEASONAL AND SPATIAL VARIABILITY OF THE PHYSICOCHEMICAL CHARACTERISTICS OF DEEP MARANHAO RESERVOIR, SOUTH OF PORTUGAL,
Instituto Nacional de Investigacao des Pescas, Lisbon (Portugal).
M. J. Brogueira, and H. Pereira.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 501-518, 11 fig, 1 tab, 30 ref.

Descriptors: *Limnology, *Water quality, *Water chemistry, *Multipurpose reservoirs, *Portugal, *Seasonal variation, *Spatial distribution, Physicochemical properties, Turbidity, Oxygen deficit, Nutrients, Phosphorus, Hydrogen ion concentration, Water temperature, Nitrates, Chlorophyll a, Primary productivity, Water quality, Mathematical studies.

The spatial variability of the physicochemical characteristics of Maranhao Reservoir, in the south of Portugal, was studied over one year period. Non-algal turbidity was most likely the main factor controlling the water transparency of the reservoir. A hypolimnetic oxygen depletion developed during summer stratification and a relative oxygen deficit of 1.1 mg/sq cm/month was quantified. Maximum values of nitrates (1.2-2.4 mg/L) and silicates (4.4-5.2 mg/L) were detected in winter, contrasting with phosphates which maximum concentrations (140-480 micrograms/L) were observed during summer/early autumn. The gross internal phosphorus loading detected from June to

October corresponded to a calculated release rate of 18 mg/sq m/day. A new method of discriminant analysis based on a modification of Principal Component Analysis was developed, and applied to the physicochemical variables. This analysis proved to be an efficient method in summarizing the variability of the physicochemical parameters along the reservoir. The gradient-depth effects on temperature, oxygen, pH, silicates, nitrates and ammonia are evident along the factor I. Factor II is clearly related to a phosphorus enrichment in the central area of the reservoir. Significant differences in surface chlorophyll-a and primary production rates from two sampling sites were observed from May to September. Effects of local nutrients input on those parameters are discussed. (Author's abstract)
W89-06140

DISSOLVED ORGANIC CARBON AND MICROBIAL ACTIVITY IN A HYPERTROPHIC AFRICAN RESERVOIR,
National Inst. for Water Research, Pretoria (South Africa).
R. D. Robarts, and P. J. Ashton.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 519-539, October 1988. 3 fig, 7 tab, 44 ref.

Descriptors: *Limnology, *Eutrophic lakes, *Eutrophication, *Reservoirs, *South Africa, *Organic carbon, *Dissolved solids, *Particulate matter, Organic matter, Phytoplankton, Primary productivity, Nonpoint pollution sources, Water pollution sources, Benthos, Path of pollutants.

A study spanning 4 years was made of the input and output of dissolved (DOC) and particulate (POC) organic carbon in the inflowing rivers and outflow of a hypertrophic, African reservoir (Hartbeespoort Dam, South Africa). Concurrent measurements were made within the reservoir of the production and utilization of DOC and POC. Phytoplankton POC production varied between 1.51 and 2.14 kg C/sq m/yr and was the dominant autochthonous source of organic carbon in the reservoir. The dominant allochthonous carbon source was treated sewage effluents which entered the reservoir via the Crocodile River; non-point sources were insignificant to the inflowing organic carbon load. The major carbon outputs were through respiratory losses (>95%), particularly benthic processes. Over the study period the reservoir had a net gain of 80.2 g C/sq m. While these calculations must be considered as tentative, they demonstrate the similarity in relative whole-lake processes in oligotrophic and hypertrophic systems, with the major difference being the magnitude of the process rates. (Author's abstract)
W89-06141

SMALL WATER COLONIZATION IN PULSE STABLE (VARZEA) AND CONSTANT (TERRA FIRME) BIOTOPES IN THE NEOTROPICS,
Max-Planck-Inst. fuer Limnologie, Schlitz (Germany, F.R.). Limnologische Flussstation.
U. Nolte.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 541-550, October 1988. 2 fig, 3 tab, 14 ref.

Descriptors: *Succession, *Benthos, *Species diversity, *Species composition, *Tropical regions, Midges, Biomass, Mayflies, Dragonflies, Adaptation, Ecology, Flood plains, Aquatic insects.

Short-term succession of macrobenthic fauna was studied in field experiments near Manaus/Amazonas (Brazil). During three months the colonization of six experimental pools (with a capacity of 1000L, each) was recorded, once in the terra firme and twice in the varzea. In all cases Chironomidae were the most important benthic colonizers in terms of their abundance, biomass, and species richness. In the varzean small waters detritophagous mayflies (Polymitarcidae) were also numerous. The benthic biomass in the terra firmean pools became dominated by predacious dragonflies (Libellulidae). Colonizer communities of both biotopes show distinct successional patterns in respect to their trophic organization and their abundance dynamics. These differences express synecological adaptations to the constant biotope terra firme and to the pulse stable varzean floodplains, respectively. Various community attributes are compared with those suggested by other researchers to be diagnostic of early successional stages. (Author's abstract)
W89-06142

NUTRIENT AVAILABILITY AND PATTERNS OF POLYMORPHISM IN THE FRESHWATER DINOFLAGELLATE, CERATIUM HIRUNDINELLA,
Oak Ridge National Lab., TN. Environmental Sciences Div.
B. L. Kimmel, and J. R. Holt.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 577-592, October 1988. 4 fig, 3 tab, 30 ref.

Descriptors: *Plankton, *Dinoflagellates, *Ceratium, *Nutrients, Nitrogen, Polymorphism, Limiting nutrients, Ecological effects, Seasonal variation, Reservoirs.

Seasonal polymorphism is widely observed in populations of the planktonic dinoflagellate, Ceratium hirundinella, but its environmental control has remained uncertain. The environmental factors affecting changes in cell size and form in populations of C. hurundinella were investigated in a large reservoir and in periodically isolated lagoons located on a mid-reservoir island. Reduction in the average size (girdle width) and a decrease in the presence of the third posterior (hypothecal) spine of Ceratium cells occurred within 10 days when island lagoons were isolated from the reservoir as a result of decreasing reservoir water level. These morphological changes were correlated with decreasing dissolved inorganic nitrogen concentrations and with increasing water temperature. To test the hypothesis that rapid changes in Ceratium cell size and form are caused by shifts in nutrient availability, an isolated lagoon was experimentally enriched. Nutrient enrichment of the lagoon resulted in rapid increases in average Ceratium cell size and in the reaction of the population having a third posterior spine, while the average cell size of Ceratium in the reservoir and in two unenriched lagoons declined. The results provide experimental evidence that changes in Ceratium cell size and form can be initiated through shifts in nutrient availability, and support previous suggestions that nitrogen availability exerts an important influence on patterns of polymorphism in Ceratium populations. (Author's abstract)
W89-06144

HIGH RATES OF DENITRIFICATION IN A STORAGE RESERVOIR FED WITH WATER OF THE RIVER RHINE,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
W. Admiraal, and J. C. van der Vlugt.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 593-605, October 1988. 7 fig, 2 tab, 15 ref.

Descriptors: *Denitrification, *Nitrogen, *Reservoirs, *Lake sediments, *Respiration, Stratification, Nitrates, Rivers, Plankton, Seasonal variation.

The nitrogen budget of a storage reservoir, used for the preparation of drinking water, was studied by measuring the input, the standing stock and the output of inorganic and organic forms of nitrogen. The very high concentration of nitrate of ca. 4 mg N/l in water pumped from the lower ranges of the river Rhine were reduced to 1.2 mg N/l in the 0.6 sq km large main basin as well as in 1600 sq m large Lund-type enclosures (rings). The top-layers of the sediment were depleted of nitrate and reduced nitrate concentrations were found above the sediment in one ring during occasional periods of stratification. Since the assimilative nitrate reduction by the plankton was relatively insignificant the net denitrification rates could be estimated for the reservoir and the enclosures. These rates varied between high levels of 15.49 g NO3--N/sq m/yr and showed relatively small differences between 7 years of observation. Limnologically different rings showed similar rates. It is postulated that the uniformly high nitrate concentrations in river-water are responsible for the importance of anoxic respiration in the sediment of the reservoirs. (Author's abstract)
W89-06145

LAKE MIXIS AND INTERNAL PHOSPHORUS DYNAMICS,
Metropolitan Council, St. Paul, MN.
R. A. Osgood.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 629-638, October 1988. 2 fig, 1 tab, 30 ref.

Descriptors: *Limnology, *Model studies, *Phosphorus, *Cycling nutrients, *Lakes, *Mixing, *Stratification, *Hydrologic models, Phosphates, Water pollution sources, Agricultural runoff, Seasonal variation.

The contribution of internal phosphorus supplies to the summertime epilimnion is related to duration and extent of mixis for lakes of the Twin Cities Metropolitan Area, Minnesota. The ratio of mean depth to the square root of surface area is closely correlated with the fraction of lake volume involved in mixis and the duration of summertime mixis. Since these two factors were not measured precisely in most lakes, the ratio of mean depth to the square root of surface area was used as a surrogate. A steady-state phosphorus model was modified by incorporating lake mixing volume and the duration of summertime stratification. This model, which replicated observations from 96 TCMA lakes, demonstrated elevated summertime surface phosphorus concentrations in polymictic lakes. (Author's abstract)
W89-06148

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 1. PHYSICAL AND CHEMICAL ENVIRONMENT,
Durham Univ. (England). Dept. of Botany.
B. A. Whitton, A. Aziz, P. Francis, J. A. Rother, and J. W. Simon.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 3-22, November 10, 1988. 8 fig, 11 tab, 29 ref. United Kingdom Overseas Development Administration Contract R3630 and R3983. Commission of the European Communities Contract TSD-A.207.

Descriptors: *Ecology, *Limnology, *Water chemistry, *Rice paddies, *Bangladesh, Water temperature, Flooding, Conductivity, Hydrogen ion concentration, Alkalinity, Dissolved oxygen, Metals, Phosphorus, Nitrogen, Sulfates, Silicon, Annual floods.

This work introduces a series of five papers describing physical, chemical and biological features of Bangladesh deepwater rice-fields. Flooding occurs typically from late June to early November. There were two distinct flood peaks (late July, mid-September) at the two main research sites during each of the years 1981-1986, with maximum depths reaching about 1.5-2.0 m. Temperature showed a narrow range, with values for the upper part of the water column during July-October seldom outside the range 29-35 C. Data for PAR (Photosynthetically Active Radiation) obtained with two types of sensor (4 pi and cosine) are summarized, with examples of profiles and changes throughout the day. Water chemistries sampled from 13 different locations at various times during 1981-1983 are compared for: conductivity, pH, total alkalinity, O2, major metals, minor metals, NH4-N, NO2-N, NO3-N, filtrable reactive P, filtrable organic P, and non-filtrable P, Cl, SO4-S, and reactive-Si. Overall the concentrations of aqueous N and P may be regarded as providing a mesotrophic environment for algae, but with relatively low N:P. Filtrable organic P was at least as important as filtrable reactive P, with mean values at the various locations from 0.020 to 0.036 mg/L P for the organic P and 0.005 to 0.038 mg/l for the reactive P. Measurements of N and P in the water column at any one time typically gave values (expressed per unit area) slightly lower than totals for these elements deposited in sediments throughout the whole season. At least until the end of September, the upper part of the water column was almost always oxic during the daytime and occasionally supersaturated with O2 in the afternoon. However DWR fields in south Bangladesh (Phaltita) visited on a sunny day in late September had waters

which were almost entirely anoxic even in the afternoon. (See W89-06150 thru W89-06153) (Author's abstract)
W89-06149

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 2. CHEMISTRY OF SITES AT MANIKGANJ AND SONARGAON,
Durham Univ. (England). Dept. of Botany.
B. A. Whitton, J. A. Rother, and A. R. Paul.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 23-30, November 10, 1988. 6 fig, 1 tab, 9 ref. United Kingdom Overseas Development Administration Contract R3630A and R3983. Commission of the European Communities Contract TSD-A.207.

Descriptors: *Ecology, *Limnology, *Water chemistry, *Bangladesh, *Rice paddies, *Flood plains, Hydrogen ion concentrations, Dissolved oxygen, Ecology, Oxygen depletion, Nitrite, Sulfates, Alkalinity, Magnesium, Calcium, Water hyacyinth.

The chemistry of water in fields at two Bangladesh deepwater rice locations is compared. Although Manikganj lies in Jamuna (-Brahmaputra) floodplain and Sonargaon in the old Meghna floodplain, their chemistries during the flood season are similar, apart from higher Mg, Ca, pH and total alkalinity at the former. Diel changes in oxygen and sometimes also pH were evident 10 cm below the surface in deepwater rice fields, but such changes were typically much greater in fallow fields. Measurements made between 1400 and 1600 hr in a range of habitats showed a trend for high pH values to be associated with high O2 values. Water in Eichhornia beds had the lowest values, deepwater rice fields were intermediate and fallow fields and other open areas typically had the highest values. O2 concentrations in excess of 15 mg/l and pH values of about 10.0 sometimes occurred in fallow fields with dense masses of submerged plants and loosely associated algal flocs. There was an increasing tendency for the water to become anoxic in deepwater rice fields at both locations over the whole 24-hr period of 4-5 October, at a time when the depth of the water was starting to drop. Nitrite increased and sulfate decreased at both locations towards the end of the season. (See also W89-06149) (Author's abstract)
W89-06150

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 4. NITROGEN FIXATION BY BLUE-GREEN ALGAL COMMUNITIES,
Durham Univ. (England). Dept. of Botany.
J. A. Rother, A. Aziz, N. H. Karim, and B. A. Whitton.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 43-56, November 10, 1988. 5 fig, 8 tab, 21 ref. United Kingdom Overseas Development Administration Contract R3630A.

Descriptors: *Ecology, *Limnology, *Cyanophyta, *Nitrogen fixation, *Rice paddies, *Bangladesh, Chlorophyll, Algae, Flooding, Ecology.

Measurements of standing crop and nitrogenase activity of blue-green algal communities were made during the flood season at two Bangladesh deepwater rice (DWR) locations, Manikganj and near Sonargaon from 1981 to 1986. Floating colonies were quantitatively important only at Manikganj, but epiphytic algae were frequent at both sites during part of each flood season. The maximum blue-green algal crops recorded for any field for floating colonies and epiphytes were 186 and 54.8 mg/sq m chlorophyll a, respectively. Mean values were much lower. Azolla was present in the majority of 0.25 sq m quadrats sampled, but seldom exceeded 10 mg dry wt/sq m. Mean rates of nitrogenase activity (ARA), expressed per unit chlorophyll, were quite similar for all the free-living species except Scytonema mirabile. The sequence of maximum values for individual species (incubated under light flux similar to that in which the organisms had been growing) came in the order (from highest to lowest): Aulosira fertillissima, Anabaena sp. (non-planktonic), Scytonema mirabile. There were marked diel changes in ARA, with the maximum in late morning or early afternoon and the minimum during the late part of the night. The use of results combined from one hour in late morning and one hour in early afternoon provides a reasonable prediction of the daily total. This 2-hr total in nine experiments representing seven species ranged from 14.8 to 22.7% of the 24-hr total. ARA of representative DWR tillers at Sonargaon near the period of peak flood was very low in 1982, but higher in August-September 1983, with totals ranging from 39.9 to 249 nmol C2H4/min/tiller. ARA was easily detectable down to node 6 and sometimes further. Estimates were made of N2 fixed inside DWR fields during the 1983 flood season. Values obtained indicate that blue-green algal nitrogen fixation is less important during the flood season than on moist soils in the period immediately prior to flooding. It is suggested that the high crops of heterocystous blue-green algae present in many fallow areas provide an important source of fixed nitrogen in the region. (See also W89-06149) (Author's abstract)
W89-06152

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 5. MINERAL COMPOSITION OF THE RICE PLANT AND OTHER AQUATIC MACROPHYTES,
Durham Univ. (England). Dept. of Botany.
J. A. Rother, and B. A. Whitton.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 57-67, November 10, 1988. 7 tab, 16 ref. United Kingdom Overseas Development Administration Contract R3630A and R3983. Commission of the European Communities Contract TSD-A.207.

Descriptors: *Ecology, *Limnology, *Rice paddies, *Bangladesh, *Macrophytes, *Minerals, Nitrogen, Phosphorus, Sodium, Zinc, Nutrients, Flooding, Aquatic weeds, Rice, Food peaks, Accumulation.

The mineral composition of deepwater rice (cultivar Kartik Sail) was studied during 1986 in a field near Sonargaon, Bangladesh, which is flooded by water from R. Meghna. Samples were taken four times, once prior to flooding and three times during the flood season. On two of the latter days (10 August = end of first flood peak, 23 September = second flood peak) the study was extended to other components of the ecosystem (sediment and soil, water, other aquatic macrophytes). On 23 September, 32% of the mass of the plant was out of water, 65% in water and 3% in sediment/soil. There were marked differences between elements in their pattern of accumulation by deepwater rice through the season. In comparison with the final totals for each element, about 48% of N, but only 11% of P and 10% of Na had been accumulated by the time the floodwater had arrived. The aquatic roots doubled in mass between the times of the two flood peaks and it is suggested that much of the P taken up by the plant may reach the plant via its aquatic roots after being mobilized and released to the water when sediments become anaerobic. In comparison with other parts of the plant, Na was always much higher in the stem and Zn in the basal roots. Other aquatic macrophytes (weeds) increased from 0.40% of the mass (dry weight) of deepwater rice on 10 August to 4.0% on 23 September. However their content of each element (% dry weight) was considerably higher than that in deepwater rice, so they may at times compete effectively with the rice for nutrients. During the flood period (to 23 September) weeds accumulated 16% of the N accumulated by rice during the same period. (See also W89-06149) (Author's abstract)
W89-06153

HYPOTHESIS ON THE ROLE OF APHANIZOMENON IN TRANSLOCATING PHOSPHORUS,
Metropolitan Council, St. Paul, MN.
R. A. Osgood.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 69-76, November 10, 1988. 5 fig, 1 tab, 32 ref.

Descriptors: *Limnology, *Phosphorus, *Lake sediments, *Cyanophyta, Nutrients, Phosphorus removal, Phytoplankton, Zooplankton, Daphnia, Chlorophyll, Nitrogen, Cycling nutrients, Aphanizomenon.

A mechanism for the upward translocation of phosphorus by flake-forming Aphanizomenon is hypothesized. Aphanizomenon germinates on oxic sediments and rises into the water column, then the flakes diurnally migrate. Observations from Spring Lake, Minnesota, indicate that Aphanizomenon translocates phosphorus to the summertime epilimnion. However, the observations cannot discriminate between which of two mechanisms related to Aphanizomenon flakes, upon germination or with subsequent diurnal migrations, is more important. The hypothesis of phosphorus transport to the epilimnion by Aphanizomenon flakes is further supported by lack of evidence of any other internal loading mechanisms which could account for the internal phosphorus load observed in Spring Lake. (Author's abstract)
W89-06154

DETECTION OF PLANKTONIC CYANOBACTERIA BY TANDEM IN VIVO FLUOROMETRY,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
For primary bibliographic entry see Field 7B.
W89-06155

LARVAL MIROGREX TERRAESANCTAE (CYPRINIDAE) OF LAKE KINNERET (ISRAEL): GROWTH RATE, PLANKTON SELECTIVITIES, CONSUMPTION RATES AND INTERACTION WITH ROTIFERS,
National Inst. of Oceanography, Haifa (Israel).
R. Landau, M. Gophen, and P. Walline.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 91-106, November 10, 1988. 6 fig, 5 tab, 39 ref.

Descriptors: *Israel, *Lake Kinneret, *Food chains, *Fish food, *Minnows, *Growth rates, Rotifers, Zooplankton, Lakes, Biomass, Fish, Predation, Limnology.

The rotifer Synchaeta pectinata dominated gut content of first feeding Mirogrex larvae (7 mm, 10 days age) and was a selected prey of neuston-caught larvae up to 15 mm TL. A negative L-value (linear index of selection) applied to predation on nauplii and copepodites by 7 and 8 mm larvae; nevertheless, caloric intake was dominated by copepods in 8-10 mm larvae. Neuston-caught larvae 13-20 mm TL fed selectively on Cladocera, especially Bosmina, and on the rotifer Asplanchna spp. Growth, estimated from otolith ring counts and from analysis of size distribution data, ranged from 3 to 7 mm/mo, with higher rates for early spawned larvae. When consumption as estimated from gut content, was compared to amounts of food required for growth, it appeared that the smallest larvae were underfed, while 13-16 mm fish obtained rations close to sufficiency. Rotifer standing stock biomass in Lake Kinneret has decreased in recent years, especially in winter, the spawning period of mirogrex. Postulated causes are predation by an increasingly large population of Mirogrex larvae, and decrease of external supply. Larval distribution appeared to be linked to S. pectinata abundance; highest densities of both organisms occurred in the area of inflow from the Jordan and Golan streams. Larval food enrichment of inflow water by fish pond drainage might have caused observed increases in Mirogrex stock size since 1960. (Author's abstract)
W89-06156

SEASONAL CHANGES IN THE UNDERWATER LIGHT CLIMATE OF TWO CANADIAN SHIELD LAKES,
Montreal Univ. (Quebec). Dept. of Biological Sciences.
P. H. Heinermann, and M. A. Ali.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 107-121, November 10, 1988. 16 fig, 1 tab, 47 ref.

Descriptors: *Spectral analysis, *Dissolved solids, *Limnology, *Light penetration, *Lakes, *Light Intensity, *Turbidity, Reflectance, Seasonal variation, Canada, Phytoplankton, Oligotrophic lakes, Mesotrophic lakes, Suspended solids, Particulate matter, Water quality, Irradiation, Color.

The seasonal variation in the underwater spectral distribution of light in a mesotrophic (Lake Cromwell) and an oligo-mesotrophic (Lake Croche) temperate lake were examined. Gilvin (dissolved organic matter or 'gelbstoff' is primarily responsible for the strong selective attenuation of blue light in both lakes. As a result of differing gilvin concentrations light transmission maxima of downwelling and upwelling spectra are near 615 nm in Lake Cromwell and 599 nm in Lake Croche. With increases in depth both upwelling and downwelling radiance fluxes decrease, and are shifted to longer wavelengths and become more monochromatic. The greatest penetration of light occurs in the summer and spring after which a gradual decrease occurs through fall to a minimum value in winter. Under the winter cover the wavelength which halved the total number of photons between 400 and 700 nm of downwelling light shifts 10 to 20 nm towards shorter wavelengths. Seasonal changes in downwelling irradiance are related to solar altitude, concentration of suspended particles, phytoplankton populations, amount of gilvin, mixing and winter cover. The brownish coloration of these lakes is explained by reflectance of spectrally impure orangish-red light. (Author's abstract)
W89-06157

PHOSPHORUS IN A MARL LAKE IN KASHMIR,
Kashmir Univ., Srinagar (India). Dept. of Botany.
M. Ishaq, and V. Kaul.
Environmental Conservation EVCNA4, Vol. 15, No. 2, p 171-175, 1988. 4 fig, 5 tab, 31 ref.

Descriptors: *Phosphorus, *Lakes, *Marl, *Lake sediments, *Cycling nutrients, Phosphates, Macrophytes, Decomposition, Organic matter, India, Spatial distribution, Orthophosphates, Limnology.

The phosphorus pools contained in water, macrophytes, and sediments, in relation to phosphorus input and output in a high-altitude marl lake in Kashmir, India were examined in the multibasin Dal Lake. Orthophosphate was determined by the sulfomolybdate method within 1-2 hours after collection of water samples. The changes occurring in the lake's volume were estimated from the continuously recorded lake-water-level data supplied by the Environmental Engineering Department at Srinagar. The phosphorus in the upper 10 cm of sediment layer was determined by integrating sediment P-concentrations estimates with an equation for the mass of the sediment. P accumulation in the macrophytic compartment of the lake was calculated using methods given by Kaul (1980). Orthophosphate ranged from 8 to 23 micrograms/L and total phosphorus from 85 to 604 micrograms/L during the study year of 1981-1982. The sediment contained an average P-pool of 706 million g. P-accumulation in the different vegetation zones of the lake varied. The emergent zone contained the maximum, followed by the submerged and then the rooted-free floating zones. The observed bimodal peak of orthophosphate was apparently related to the decomposition processes which set in with the onset of spring and lasted through autumn, both seasons having the least vegetative growth. The total phosphorus peak coincided with senescence and the period of decaying of organic matter. The water and macrophytic components jointly contained only 1.1% of the total p-pool of the lake, even though both the macrophytic density and total P concentrations in the lake water were high. The main store of P lies in the sediments, which are known to serve as long-term sinks, apparently due to the high settling rate of P, co-precipitated from the alkaline calcium-rich water column and also aided by biological processes. The type of sediments common in Dal Lake, clay-loam have been shown to act as an efficient P-sink that release very little of the nutrient in compared to the amount of P stored. (Geiger-PTT)
W89-06161

REHABILITATIVE REDEVELOPMENT OF THE FISH AND FISHERIES OF THE BALTIC SEA AND THE GREAT LAKES,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 8I.
W89-06166

LAKE ACIDIFICATION IN NORWAY: PRESENT AND PREDICTED CHEMICAL STATUS,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W89-06174

METHOD FOR INSTALLING AND MONITORING PIEZOMETERS IN BEDS OF SURFACE WATERS,
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
For primary bibliographic entry see Field 7B.
W89-06208

HEAVY METAL CONCENTRATIONS OF LYMNAEA STAGNALIS L. IN THE ENVIRONS OF LAKE BALATON (HUNGARY),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5A.
W89-06215

ALGAL BIOASSAYS IN EUTROPHICATION RESEARCH: A DISCUSSION IN THE FRAMEWORK OF A MATHEMATICAL ANALYSIS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 5G.
W89-06226

INTERRELATIONSHIPS BETWEEN THE GROWTH OF HYDRILLA VERTICILLATA (L.F.) ROYLE AND SEDIMENT NUTRIENT AVAILABILITY,
Waterways Experiment Station, Vicksburg, MS.
J. W. Barko, R. M. Smart, D. G. McFarland, and R. L. Chen.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 205-216, November 1988. 1 tab, 6 fig, 34 ref.

Descriptors: *Aquatic plants, *Macrophytes, *Vegetation, *Limiting nutrients, *Nutrient requirements, *Plant growth, Plant physiology, Flora, Sediments, Hydrilla, Nitrogen, Phosphorus, Potassium, Nutrients.

On sediment planted with Hydrilla verticillata (L.f.) Royle compared with control (unplanted) sediment > 90% and > 30% reductions in concentrations of exchangeable N and extractable P were measured following two consecutive 6-week periods of growth. Diminished N availability, due to prior plant uptake, resulted in a 30% reduction in Hydrilla growth. Concomitant increases (> 30%) in the concentration of exchangeable K suggest that this element, obtained via foliar uptake from overlying water, may be exchanged by roots of Hydrilla for ammonium in sediment. It is postulated that under N-limiting conditions, K translocation in this species from shoots to roots potentially increases the availability of sediment N. An important implication of these findings is that under some circumstances the growth of Hydrilla may be self-limiting. (Author's abstract)
W89-06248

BIOMASS VARIANCE FUNCTION FOR AQUATIC MACROPHYTES IN ONTARIO (CANADA) SHIELD LAKES,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
R. L. France.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 217-224, November 1988. 3 fig, 19 ref.

Descriptors: *Limnology, *Aquatic plants, *Biomass, *Macrophytes, *Vegetatior., *Lakes, *Statistical analysis, Statistical methods, Statistics, Variance, Poisson distribution, Negative binomial distribution, Downing and Anderson distribution, Plant populations, Ontario, Canada, Soft-water lakes.

The spatial variability of macrophyte biomass was examined in 18 soft-water lakes in Ontario, Canada. A variance function was fitted to the data and then tested independently against three other distributions (Poisson, negative binomial, Downing and Anderson) to determine the accuracy of prediction of variance. Macrophyte biomass in these lakes is highly aggregated and follows a negative binomial distribution. With aggregated distribution data transformations must be applied to stabilize variances before parametric analyses are undertaken. The choice of correct transformation is dependent on the variance to mean ratio, and therefore the spatial distribution of the sampled population. At least 21 replicate samples are required to achieve a level of precision of + or - 20% of the mean biomass when using a sampler within an area of 45.6 sq cm. Selection of the negative binomial distribution as the best fitting model for variance prediction is not surprising in view of the curvilinear trend to the relationship of the log of the mean to the log of the variance. (White-Reimer-PTT)
W89-06249

ECOLOGICAL STUDIES ON POTAMOGETON PECTINATUS L. II. AUTECOLOGICAL CHARACTERISTICS, WITH EMPHASIS ON SALT TOLERANCE, INTRASPECIFIC VARIATION AND ISOENZYME PATTERNS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
R. J. van Wijk, E. M. J. van Goor, and J. A. C. Verkley.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 239-260, November 1988. 2 tab, 11 fig, 33 ref.

Descriptors: *Saline water, *Aquatic plants, *Macrophytes, *Vegetation, *Ecological distribution, Intraspecific variation, Niches, Ecotypes, *Plant populations, *Culturing techniques, Potamogeton, Sago pondweed, Salinity, Fresh water, Brackish water, Turbidity, Growth rates, Autecolgical characteristics, Isoenzyme patterns.

Intraspecific variation between populations in culture was recorded for tuber production, type of tubers, salinity optimum for shoot and biomass production and shoot-length distribution. Plants from freshwater populations produced more double tubers and produced tubers in an earlier growth stage than plants from brackish habitats. Plants from brackish-water populations showed best growth at low salinities in terms of shoots and biomass production, while plants from the freshwater populations grew best in freshwater. Experiments involving different light conditions suggest that shoot-length distribution of the different populations can be an adaptation to turbidity. The marked differences between populations cultured under identical conditions indicate genetic differentiation, and the existence of different ecotypes. The isoenzyme analyses of the different populations show that P. pectinatus is genetically very heterogeneous. The differentiation of populations based on the isoenzyme patterns appears to be more complicated than the differentiation as established in the culture experiments. (Author's abstract)
W89-06250

SIGNIFICANCE OF SEDIMENTARY PHOSPHORUS TO A ROOTED SUBMERSED MACROPHYTE (NAJAS FLEXILIS (WILLD.) ROSTK. AND SCHMIDT) AND ITS ALGAL EPIPHYTES,
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
R. E. Moeller, J. M. Burkholder, and R. G. Wetzel.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 261-281, November 1988. 3 tab, 5 fig, 36 ref. NSF Grant BSR-80-01190, and DOE Grant DE-AC0276EV01599,COO-1599-309.

Descriptors: *Aquatic plants, *Macrophytes, *Epiphytes, *Algae, *Nutrients, *Phosphorus, Cycling nutrients, Sediments, Najas flexilis, Gomphonema, Achnanthes, Mougeotia, Nuclear track microautoradiography.

Seedlings of a submersed angiosperm were grown to mature size in small, calcareous sediment-water systems labelled with radiophosphorus to reveal long-term patterns of phosphorus uptake, translocation to shoots, and utilization by algal epiphytes.

Shoots of Najas flexilis (Willd) Rostk. and Schmidt derived P almost exclusively from the sediment (> 99%) and released P only sparingly to epiphytes and water (2% of cumulative uptake after 5 wk). Release of P averaged 3.5 micrograms P/g shoot dry wt a day. Release was independent of shoot P concentrations over the range 0.12-0.54% dry wt, which was induced by varying P availability to roots. Nuclear track microautoradiography using P33 was applied to compare utilization of macrophyte-derived P by several epiphytic taxa. Filamentous Mougeotia and long-stalked Gomphonema depended more on the external, P-poor lakewater medium than did small adnate forms like Achnanthes. Epiphytic participation in the open-water P cycle, ultimately helps to sustain the apparently independent P cycle of rooted macrophytes, by increasing P deposition as littoral sediment. (Author's abstract)
W89-06251

EFFECT OF FLOODING ON WILD RICE, ZIZANIA AQUATICA L.,
Winnipeg Univ. (Manitoba). Dept. of Biology.
E. Pip, and J. Stepaniuk.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 283-290, November 1988. 3 fig, 14 ref.

Descriptors: *Aquatic plants, *Flooding, *Macrophytes, *Plant growth, *Vegetation, Wild rice, Zizania aquatica, Proteins, Carbohydrates, Seeds, Growth, Growth rates, Manitoba, Canada.

A natural wild rice stand in eastern Manitoba was studied during a normal growing season and a season characterized by major midsummer flooding. Flooding was associated with severe declines in total soluble-carbohydrate content of all organs at the end of the season, and failure to set seed. Total soluble-protein content showed large fluctuations, which were possibly related to protein catabolism. Plants growing at stable, normal water levels showed moderate concentrations of total soluble protein, and soluble-carbohydrate levels increased in all organs during seed production; much of these resources appeared to originate in the aerial leaves. Seasonal soluble-carbohydrate levels of many submerged organs were inversely correlated with water temperature. Air lacunae were greatly expanded in floating and aerial leaves subjected to submersion. (Author's abstract)
W89-06252

DISTRIBUTION AND ABUNDANCE OF HERBACEOUS ANGIOSPERMS IN WEST-CENTRAL FLORIDA MARSHES,
University of South Florida, Tampa. Dept. of Biology.
P. S. Botts, and B. C. Cowell.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 225-238, November 1988. 1 tab, 5 fig, 26 ref.

Descriptors: *Water level fluctuations, *Marshes, *Wetlands, *Swamps, *Florida, Storm runoff, Vegetation, Flora, Plant populations, Macrophytes, Angiosperms, Distribution, Abundance, Water depth, Grass-sedge marshes, Cluster analysis, Reciprocal averaging, Biotic boundary technique.

Cluster analysis, reciprocal averaging and a biotic boundary technique were used to analyze the relationship between community composition and topographic depth within four grass-sedge marshes in west-central Florida. Abundances of species fluctuated seasonally and varied between marshes. Communities in deep areas of individual marshes differed markedly from each other and from those in shallow areas. Reciprocal averaging showed no floristic gradients in the shallow marshes, but strong floristic gradients were highly correlated with water regime in deep marshes. Biotic boundaries within the marshes corresponded with water levels. The biotic boundary technique clearly delineated communities within the marshes and reflected the importance of seasonal water level fluctuations for community composition. The sensitivity of marshes in general, and of these marshes specifically, to water-regime changes makes the current practice of using marshes as storm water runoff retention ponds questionable, since the resulting changes in water levels and drainage patterns may markedly affect the plant communities. (Author's abstract)
W89-06254

SEASONAL VARIATION OF PHOSPHORUS RELEASE FROM THE SEDIMENTS OF SHALLOW LAKE BALATON (HUNGARY),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
V. Istvanovics.
Water Research WATRAG, Vol. 22, No. 12, p 1473-1481, December 1988. 4 fig, 5 tab, 40 ref.

Descriptors: *Cycling nutrients, *Phosphorus, *Lake sediments, *Hungary, Seasonal variation, Hungary, Sediment-water interfaces, Hydrogen ion concentration.

Phosphorus release was low from intact sediment cores of the mesotrophic area of lake Balaton throughout the year, and amounted to 0.3 mg P/sq m/day during autumn in short-term incubations. In the hypertrophic area maximum release (2.8 mg P/sq m/day) was measured during the summer. Phosphorus release showed a rapid increase from long-term incubated intact sediment cores with increasing pH of the overlying water. At the ecologically real maximum pH the release may amount to 0.8 and 4.0 mg P/sq m/day in the mesotrophic and hypertropic areas, respectively. A release of 2.0-3.9 mg P/sq m/day was estimated from sediment suspensions of the hypertropic area within a pH range of 8-9. These values are similar to the external phosphorus loadings of the respective areas. The most important phosphorus mobilizing factors are pH and the decomposition of the organic matter in the sediments. Redox conditions may play a significant indirect role in the regulation of the internal loading. A positive feedback is hypothesized between the internal phosphorus loading and primary production, both processes being affected by the external loading in different ways. (Author's abstract)
W89-06293

FACTORS INFLUENCING PHOTOSYNTHETIC PRODUCTIVITY OF CHARA VULGARIS L. IN A MODERATELY PRODUCTIVE HARD-WATER LAKE,
Wayne State Univ., Detroit, MI. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2I.
W89-06317

BENTHIC COMMUNITY METABOLISM IN TWO NORTHERN MISSISSIPPI STREAMS,
Fish and Wildlife Service, Cookeville, TN. Ecological Services Office.
T. J. Naimo, and J. B. Layzer.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 503-515, December 1988. 1 fig, 6 tab, 38 ref.

Descriptors: *Benthos, *Stream biota, *Metabolism, *Aquatic productivity, *Primary productivity, Ecosystems, Respiration, Bacteria, Mississippi, Regression analyses, Nitrates, Chlorophyll.

Seasonal estimates of metabolism were determined with closed, replicate, 12-liter recirculating chambers on an artificially constructed gravel bar in a seventh order stream, the Tombigbee River, and on a natural riffle in a fourth order stream, the Buttahatchie River. In the Tombigbee and Buttahatchie rivers, the respective ranges for metabolism parameters were as follows (in g O2/sq m/d): gross community primary productivity, -0.39 to 2.97 and 0.06 to 0.44; net community primary productivity, -0.72 to 2.38 and -0.50 to 0.11; community respiration, 0.60 to 6.00 and 0.24 to 1.04; net daily metabolism, -3.22 to 1.61 and -0.90 to -0.01; and ratios of gross community primary productivity to 24 hour community respiration (P/R), 0.38 to 2.01 and 0.09 to 0.98. Stepwise multiple linear regression indicated that most of the variation in metabolism parameters was explained by temperature, detritus, substrate-level light, and total Kjeldahl nitrogen in the Buttahatchie River, and by turbidity, temperature, chlorophyll, and nitrate-nitrogen in the Tombigbee River. Both rivers were predominately heterotrophic. The Tombigbee River was autotrophic only in January, at which time an algal-based community existed. During all other sampling periods, both communities were dominated by bacteria and utilized allochthonous inputs. (Author's abstract)
W89-06322

EFFECTS OF WAVE ENERGY ON PLANT ESTABLISHMENT IN SHALLOW LACUSTRINE WETLANDS,
Utah State Univ., Logan. Dept. of Fisheries and Wildlife.
A. L. Foote, and J. A. Kadlec.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 523-532, December 1988. 3 fig, 1 tab, 20 ref.

Descriptors: *Vegetation establishment, *Wetlands, *Mud flats, *Tidal flats, *Saline lakes, *Great Salt Lake, *Wave action, Lakes, Vegetation effects, Sedimentation, Suspended sediments, Bulrushes, Seeds.

Four sampling stations were randomly chosen in each of three wetlands in the Bear River Bay of Great Salt Lake, Utah. To measure mud flat sedimentation rates, two sediment traps were installed at each sampling station. Resuspension area of the two flooded mud flats was compared with resuspension rates of the vegetated marsh (Bear River). Results show that daily sedimentation rates were not as strongly influenced by vegetation as they were by other factors that were not measured. Wave energy resuspended a minimum of 18 and a maximum of 511 metric tons of sediment per ha each month in mud flats. Large amounts of sediment were resuspended in all areas sampled. Sediments traps also captured seeds that were removed from the seed bank when sediments were resuspended. Wave break exclosures were used to compare survival of alkali bulrush buds planted on protected sites with those planted on exposed sites. Protected buds had approximately twice the survival rate as exposed buds. Although the fate of some of the unprotected buds is unknown, these results indicate that protection from waves improves bud survival. However, protection may entail some risk as well. Sediment surface elevations within and behind the wave exclosures were several cm higher by the end of the growing season, suggesting that our protective exclosures reduced wave energy enough to let suspended sediments settle. (VerNooy-PTT)
W89-06323

NUTRIENT DYNAMICS OF A SUBMERSED MACROPHYTE COMMUNITY IN A STREAM ECOSYSTEM DOMINATED BY POTAMOGETON PECTINATUS L.,
Rensselaer Polytechnic Inst., Troy, NY. Rensselaer Fresh Water Inst.
J. D. Madsen, and M. S. Adams.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 541-550, December 1988. 3 fig, 2 tab, 29 ref.

Descriptors: *Cycling nutrients, *Limiting nutrients, *Submerged plants, *Macrophytes, *Aquatic vegetation, Nutrient requirements, Ecosystems, Stream pollution, Nutrients, Potamogeton, Effluents.

The nutrient dynamics of a submersed macrophyte community dominated by Potamogeton pectinatus L. in stream receiving sewage effluent was studied for one calendar year. Major sampling sites for water chemistry and flow were located at the Nine Springs Sewage Treatment Plant, at Badfish Creek south of Madison, Wisconsin. A mass balance approach demonstrated that the Potamogeton community was unimportant (less than 1%) to annual N, P and K dynamics. In addition, these nutrients did not limit macrophyte productivity. Tissue nutrient concentrations for three nutrients examined averaged: N (4.16%), P (0.723%), and K (1.66%). Tissue nutrient concentrations were above critical concentrations. Macrophytes were not a significant seasonal reservoir of nutrients, with daily commu-

nity uptake rates always less than 5% of daily nutrient loading rates. (Author's abstract)
W89-06324

NITROGEN CYCLING IN ALTERED AND NEWLY CREATED LAKES NEAR THE MOUNT ST. HELENS VOLCANO,
Washington Univ., Seattle. Coll. of Ocean and Fishery Sciences.
R. C. Wissmar, J. A. Baross, M. D. Lilley, and C. N. Dahm.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 551-568, December 1988. 10 fig, 4 tab, 55 ref. NSF Grants DEB 7811339 and 811307 and Dept. of Agriculture Forest Service Agreement PNW-80-178.

Descriptors: *Limnology, *Nitrogen cycle, *Volcanoes, *Mt. St. Helens, *Lakes, *Cycling nutrients, Nitrogen compounds, Mixobacteria, Limiting nutrients, Heterotrophic bacteria, Nitrification, Phosphorus, Sulfur, Manganese, Iron, Carbon dioxide, Methane.

Studies in 1981 assessed the role of nitrogen cycle reactions and related microbial and chemical changes in volcanically impacted Spirit Lake and newly created South Castle and North Coldwater Lakes within Mt. St. Helens' blast zone. These lakes displayed characteristics of nutrient limitation and a favorable environment of involvement of mixitrophic bacterial utilization of nitrogen. Mixitrophy was implied by : co-occurrence of both nitrification and denitrification; possible influences of several nitrogen dissimilatory nitrate reduction and assimilatory reactions on the formation and consumption of nitrogen intermediates like N2O; possible Mn/S oxidizing bacteria involvement in denitrification; and changes in concentrations of CO2, CH4 and dissolved inorganic nitrogen, phosphorus, sulfur, Mn and Fe species. Microbial and chemical measurements show: assimilative N-cycle reactions and phosphate limitation playing increasingly important roles in aerobic strata; and dissimilative nitrogen and other microbially-geochemically mediated chemical reactions dominating in anaerobic hypolimnia and sediments. (Author's abstract)
W89-06325

HYDROLOGY OF LAKE AMADEUS, A GROUNDWATER-DISCHARGE PLAYA IN CENTRAL AUSTRALIA,
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
For primary bibliographic entry see Field 2F.
W89-06327

ISOLATION OF ENTEROPATHOGENIC AND ENTEROTOXIGENIC ESCHERICHIA COLI FROM THE DAL LAKE WATER OF KASHMIR,
Sher-i-Kashmir Inst. of Medical Sciences, Srinagar (India). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W89-06331

GREAT LAKE MANITOULIN: GEORGIAN BAY AND THE NORTH CHANNEL,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5B.
W89-06335

PHYSICAL LIMNOLOGY OF GEORGIAN BAY,
Bedford Inst. of Oceanography, Dartmouth (Nova Scotia). Dept. of Fisheries and Oceans.
E. B. Bennett.
Hydrobiologia HYDRB8, Vol. 163, p 21-34, June 20, 1988. 9 fig, 5 tab, 6 ref.

Descriptors: *Lakes, *Limnology, *Water circulation, *Georgian Bay, *Lake Huron, Great Lakes, Precipitation, Runoff, Evaporation, Water level, Hydrologic budget, North Channel, Water temperature, Wind-driven currents, Water exchange, Mixing, Stratification.

Limnologic data were collected at 51 stations in Georgian Bay during 1974. The major components of the water balance and their totals for the year 1974 expressed as cm change of lake level were (1) precipitation, 89.1; (2) runoff from the drainage basin, 135.8; (3) evaporation, 95.1; (4) flow to North Channel, 20.6; and (5) change of lake level, 10.4. The minimum surface temperature persisted for one month beginning in late February maximum surface temperatures occurred in early August (19 C). The annual heat income for Georgian Bay was estimated to be 43,700 cal/sq cm. The spring convective periods started by mid-April, and mixing everywhere to the bottom continued until mid-June. Lakewide stratification was present at the end of June, with the surface layer becoming about 10 m deep. Winds were weak in June and July. Generally, the daily net flow was easterly into Georgian Bay whenever relatively strong winds occurred. In July through October, the flow in cubic meters per second was about 100 times the wind speed as measured in meters per second. The exchange at Main Cannel had a significant influence on water residence and flushing times in Georgian Bay. (See also W89-06335) (Cassar-PTT)
W89-06336

DISTRIBUTION AND COMPOSITION OF THE SURFICIAL SEDIMENTS OF GEORGIAN BAY AND NORTH CHANNEL,
International Joint Commission-United States and Canada, Windsor (Ontario).
R. L. Thomas.
Hydrobiologia HYDRB8, Vol. 163, p 35-45, June 20, 1988. 4 fig, 5 tab, 8 ref.

Descriptors: *Sedimentology, *Sediment distribution, *Bottom sampling, *Lakes, *Limnology, *Lake sediments, *Georgian Bay, *Lake Huron, Path of pollutants, Heavy metals, Great Lakes, North Channel, Glacial sediments, Sediment grading, Trace elements, Mercury, Lead, Zinc, Arsenic, Oxidation-reduction potential, Sodium, Silicon, Mineralization, Industrial wastes.

The surficial 3 cm of sediment was analyzed in 177 samples collected in Georgian Bay and the North Channel (Lake Huron) in 1973. Non-depositional sediments were coarser than depositional basin sediments. The distribution of Eh values or redox potential for Georgian Bay showed the oxidizing nature of the surficial sediments. The lower the Eh value in the sediment, the more enriched and productive was the overlying water. Eh was generally lower in finer grained sediments. The concentrations of all major chemical elements (aluminum, magnesium, calcium, potassium, titanium, phosphorus, manganese, sulfur, iron) were higher in the depositional basin sediments than in the non-depositional zone. Sodium concentrations were remarkably consistent throughout all the sediments, whereas silicon was inversely related to the remaining major elements with a decrease from the non-depositional zone to the depositional basins. Trace metals levels increased from non-depositional zones to the fine-grained deposits of the depositional basins. The metals levels in Lake Superior, Lake Huron, and Georgian Bay were compared. In Georgian Bay high levels of Hg, As, Pb and Zn were seen in some basin sediments. These are due to sphalerite mineralization extending eastward from known occurrences in the Bruce Peninsula. Hg enrichment has occurred in the southern part of Georgian Bay, presumably from industrial input. (See also W89-06335) (Cassar-PTT)
W89-06337

GEOLOGY AND ENVIROMENTAL SIGNIFICANCE OF SEDIMENT DISTRIBUTIONS IN AN AREA OF THE SUBMERGED NIAGARA ESCARPMENT, GEORGIAN BAY,
Canada Centre for Inland Waters, Burlington (Ontario).
P. G. Sly, and R. G. Sandilands.
Hydrobiologia HYDRB8, Vol. 163, p 47-76, June 20, 1988. 28 fig, 6 tab, 34 ref.

Descriptors: *Sediment distribution, *Aquatic environment, *Georgian Bay, *Lake Huron, *Lakes, *Sediments, *Geology, *Benthos, Great Lakes, Particle size, Organic carbon, Glacial sediments, Trace metals, Heavy metals, Lead, Mercury, Copper, Invertebrates, Benthic fauna, Pontoporeia, Oligochaetes, Midges, Limnology, Geochemistry, Oxidation-reduction potential, Sculpin.

In the study area of Georgian Bay (a spur of the Niagara Escarpment and part of the Flowerpot basin) bedrock is exposed on islands and shoals, but much of the area is covered with 10 to 20 m of glacial till. Glaciolacustrine clay occurs in thin patches on the spur and in deposits up to 70 m deep in the deepest parts. The distribution of recent sediments (lag-gravels, sands, and silty clays) reflect major postglacial lake level changes in the Huron-Georgian Bay basin. The preglacial Lake Algonquin (110-120 m above present lake level) was succeeded by a low level lake (120-130 m below present lake level). Sediment geochemistry in Georgian Bay is similar to other parts of the Great Lakes, but calcium carbonate levels are lower than expected, except in some deposits of glaciolacustrine clay. Anthropogenic loadings of nutrients and trace metals show no major influence on sediment composition. Hg is present at low levels except for anomalously high values in some deepwater modern deposits. The high positive Eh values at a sediment depth of 1.5 to 2.0 cm indicate strongly oxidizing conditions over most of the lake bed. In the benthos chironomid concentrations were greatest in sandy sediments and in fine silty clays, with maxima at 65 and 95 m depths. Oligochaetes are least in areas of thin recent mud or exposed glaciolacustrine clay. Pontoporeia and sculpins are most numerous at depths between 50-110 m, as shown in underwater photographs of burrows and fin marks. (See also W89-06335) (Cassar-PTT)
W89-06338

CHEMICAL LIMNOLOGY OF GEORGIAN BAY AND THE NORTH CHANNEL BETWEEN 1974 AND 1980,
Ontario Ministry of the Environment, Toronto. Hazardous Contaminants Coordination Branch.
R. R. Weller.
Hydrobiologia HYDRB8, Vol. 163, p 77-83, June 20, 1988. 2 fig, 9 ref.

Descriptors: *Water chemistry, *Lakes, *Eutrophication, *Limnology, *Lake Huron, *Georgian Bay, North Channel, Oligotrophic lakes, Nutrients, Water quality, Phosphorus, St. Mary's River, Sault Ste. Marie, Geology, Water circulation, Water pollution sources, Path of pollutants, Chemical properties, Great Lakes, Water exchange.

Intensive surveys of Georgian Bay and the North Channel were done in 1974 and 1980. This paper reviews the main findings of the surveys and describes the main factors that determine the chemistry of the two water bodies. Georgian Bay is oligotrophic. Its chemistry is determined chiefly by natural phenomena, specifically the geology of the drainage basin and the river runoff in the spring, and by exchange with Lake Huron and the North Channel. Localized eutrophication is found in the bays along the southern shore. The chemistry of the North Channel is determined by its very short residence time (about two years) caused by the large inflow from St. Mary's River. The water quality in the river reflects that of Lake Superior and the inputs of nutrients and contaminants from Sault Ste. Marie. Because of the short flushing time, the channel remains oligotrophic despite the large loadings of phosphorus. (See also W89-06335) (Author's abstract)
W89-06339

PHYTOPLANKTON AND PHOSPHORUS IN SOUTHERN GEORGIAN BAY, 1973-1982, AND IMPLICATIONS FOR PHOSPHORUS LOADING CONTROLS,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
For primary bibliographic entry see Field 5B.
W89-06340

GEORGIAN BAY PHYTOPLANKTON ECOLOGY AND RESPONSE TO CONTAMINANTS,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 5C.
W89-06341

PHYCOLOGICAL STUDIES IN THE NORTH CHANNEL, LAKE HURON,
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, I. F. Munawar, L. H. McCarthy, and H. C. Duthie.
Hydrobiologia HYDRB8, Vol. 163, p 119-134, June 20, 1988. 10 fig, 5 tab, 24 ref.

Descriptors: *Water pollution effects, *Lakes, *Phytoplankton, *Lake Huron, *Productivity, Algae, Oligotrophic lakes, Primary productivity, Diatoms, Chrysophyta, Cryptophyta, Chlorophyta, Chlorophyll, Stratification, Nutrients, Metals, Biomass, Bioassay, Flushing, Temperature effects, Lake Superior, Limnology, North Channel, Great Lakes.

The phytoplankton of North Channel in Lake Huron and its productivity were studied at 8 stations distributed across the channel during May to October 1974. The mean percent biomass at each station indicated Diatomeae (59-77%) and phytoflagellates such as Chrysophyceae (4-21%) and Cryptophyceae (7-19%) as the dominant contributors. Seasonal variations of biomass ranged from 0.2 to 0.35 g per cu m with a single peak during stratified conditions. Diatomeae dominated throughout the period of investigation followed by Chrysophyceae and Cryptophyceae. Biomass composition by size revealed the dominance of ultraplankton (5-20 micrometer) which contributed 29-68% to the total biomass. Species such as Fragilaria crotonensis, Tabellaria fenestrata, Synedra acus var. radians, Cyclotella comta and C. bodanica made substantial contributions during the unstratified and stratified conditions. Ultraplankton contributed overwhelmingly to the primary productivity as measued by carbon-14 uptake. The contaminant bioassays with single metals, metals in combination and a mixture of metals demonstrated that the ultraplankton's carbon assimilation was inhibited significantly, revealing their sensitivity to contaminants. Phytoplankton ecology of the channel appears to be affected by tributary inflows, industrial/municipal inputs, and short flushing times. However, statistical treatment of the ultraplankton biomass showed correlations with temperature and nutrients. Based on phycological and limnological characteristics, the Channel appears to be oligotrophic. The chlorophyll/biomass ratios and Activity Coefficient (P/B) align it with the most oligotrophic Lake Superior in metabolic efficiency. (See also W89-06335) (Author's abstract)
W89-06342

PLANKTON COMMUNITY STRUCTURE AND SIZE SPECTRA IN THE GEORGIAN BAY AND NORTH CHANNEL ECOSYSTEMS,
Erindale Coll., Mississauga (Ontario). Dept. of Zoology.
W. G. Sprules, M. Munawar, and E. H. Jin.
Hydrobiologia HYDRB8, Vol. 163, p 135-140, June 20, 1988. 2 fig, 5 tab, 25 ref.

Descriptors: *Copepods, *Plankton, *Lakes, *Limnology, *Diatoms, Lake Huron, Georgian Bay, North Channel, Algae, Invertebrates, Oligotrophic lakes, Chrysophyta, Cyanophyta, Calanoida, Phytoplankton, Zooplankton, Great Lakes, Biomass, Waterfleas, Rotifers.

Zooplankton and phytoplankton were surveyed in Georgian Bay and North Channel during 1974. Mean seasonal zooplankton biomasses were 229.5 and 224.8 microgram per liter in North Channel and Georgian Bay, respectively. In both systems copepods constituted the greatest proportion (76-79%) of the zooplankton biomass, with calanoids more abundant than cyclopoids. Cladocerans comprised 16-19% of the mean seasonal biomass, with rotifers and the larger invertebrate predators being of minor importance. In the phytoplankton biomass of Georgian Bay the Diatomeae contributed the greatest amount (52%), followed by Chrysophyceae (15%), and Cyanophyta (12%). In North Channel Diatomeae were prevalent (66%), followed by Cyanophyta (13%). Normalized plankton biomasspectra for both ecosystems are typical of those found in Lake Superior and offshore Lake Huron--oligotrophic. (See also W89-06335)
W89-06343

BENTHIC MACRO-ALGAE OF GEORGIAN BAY, THE NORTH CHANNEL AND THEIR DRAINAGE BASIN,
Rhode Island Univ., Kingston. Dept. of Botany.
R. G. Sheath, J. A. Hambrook, and C. A. Nerone.
Hydrobiologia HYDRB8, Vol. 163, p 141-148, June 20, 1988. 10 fig, 2 tab, 43 ref.

Descriptors: *Benthic flora, *Catchment areas, *Lakes, *Limnology, *Aquatic plants, *Algae, *Macrophytes, *Lake Huron, *Georgian Bay, Great Lakes, North Channel, Cladophora, Chara, Rivers, Species composition, Ecological distribution, Limiting nutrients, Standing crops, Biomass.

Thirty-nine subgeneric taxa of macroalgae were collected from 83 sites in Georgian Bay, the North Channel and their drainage basin. There were 15 species in the Bay and Channel and 32 species in streams, rivers and impoundments in the basin. Only 8 of the Bay and Channel species were also found in the watershed. Cladophora glomerata was the most important species in Georgian Bay and the North Channel, having an estimated 640,000 sq m cover and 190,000 fresh weight standing crop. However, this species was largely concentrated on the southwestern shorelines of these water bodies. Its distribution along the northeastern shoreline appears to be limited by total ion and phosphorus levels. Chara globularis/vulgaris was the subdominant taxon in Georgian Bay and the North Channel with an estimated 70,000 sq m cover and 15,000 kg fresh weight biomass. This species was more widely distributed than C. glomerata. No other taxon contributed significantly to the standing crop. The maximum benthic macroalgal biomass was estimated to be approximately 10% of the phytoplanton biomass. (See also W89-06335) (Author's abstract)
W89-06344

DOMINANT ATTACHED FILAMENTOUS ALGAE OF GEORGIAN BAY, THE NORTH CHANNEL AND EASTERN LAKE HURON: FIELD ECOLOGY AND BIOMONITORING POTENTIAL DURING 1980,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
M. B. Jackson.
Hydrobiologia HYDRB8, Vol. 163, p 149-171, June 20, 1988. 6 fig, 8 tab, 29 ref.

Descriptors: *Water temperature, *Water pollution effects, *Lakes, *Limnology, *Algae, *Nutrients, *Lake Huron, Georgian Bay, North Channel, Ulothrix, Cladophora, Filamentous algae, Bangia, Trace metals, Chromium, Copper, Nickel, Lead, Bioaccumulation, Species composition, Ecological distribution, Light quality, Limiting nutrients, Enrichment, Impaired water quality, Municipal wastewater, Leaching, Path of pollutants, Aquatic plants, Phosphorus.

Field investigations during the ice-free period of 1980 confirmed that the dominant attached filamentous algae in the Canadian waters of Lake Huron were the green algae Ulothrix zonata and Cladophora glomerata, and the red alga Bangia atropurpurea. Consideration of temperature, light, turbulence, nutrients and substrate availability showed that temperature controlled seasonal periodicity and nutrient availability limited distribution. Remote shorelines were largely devoid of attached filamentous algae, even though growth conditions were favorable. This was attributed to low phosphorus and/or halide levels. Algae were found in areas enriched by natural or anthropogenic nutrients. The beginning of water quality degradation was marked by an increase in Ulothrix distribution, followed by fringing Cladophora, then submerged Cladophora. The filamentous algae accumulated elements in proportion to their availability in the surrounding water. Maximum algal metal concentrations (Cr, 29.0; Cu, 46.6; Ni, 34.0; Pb, 55.0, all in microgram/gram) were found at municipal wastewater outfalls, river mouths, and harbors. Metals levels found at remote sites in eastern Georgian Bay were attributed to leaching from soil and rock. These were as follows: Cr, 12.0-15.5; Cu, 18.0; Ni, 15.0-16.0; and Pb, 8.5-8.8, all in microgram/gram). (See also W89-06335) (Cassar-PTT)
W89-06345

ZOOPLANKTON FILTRATION RATES IN LAKE HURON, GEORGIAN BAY AND NORTH CHANNEL,
Illinois Natural History Survey, Champaign.
P. E. Ross, and M. Munawar.
Hydrobiologia HYDRB8, Vol. 163, p 173-177, June 20, 1988. 2 fig, 2 tab, 9 ref. Fisheries and Oceans Canada Project 80-FR-141.

Descriptors: *Lake Huron, *Georgian Bay, *Feeding rates, *Filtration, *Food chains, *Lakes, *Limnology, *Zooplankton, Phytoplankton, Great Lakes, North Channel, Algae, Biomass.

Zooplankton community filtration rates (7200 to 137,000 ml/d/cu m) were measured at four stations: Saginaw Bay, mid-Lake Huron, Georgian Bay and North Channel. Highest rates were observed during late September. The smallest size class of food yielded the highest filtration rate. Community feeding rates for late May were calculated for Georgian Bay and North Channel of 0.09 and 0.015 mg C per cu m per day, respectively. Percent cropping rates were 0.74 and 0.35 per day, respectively. Comparison of feeding rates to literature values for zooplankton biomass showed that algal food alone does not support the population. (See also W89-06335) (Cassar-PTT)
W89-06346

CHANGES IN THE GEORGIAN BAY FISH COMMUNITY, WITH SPECIAL REFERENCE TO LAKE TROUT (SALVELINUS NAMAYCUSH) REHABILITATION,
Ontario Ministry of Natural Resources, Toronto. Lake Huron Fisheries Research Unit.
B. A. Henderson, and N. R. Payne.
Hydrobiologia HYDRB8, Vol. 163, p 179-194, June 20, 1988. 9 fig, 6 tab, 40 ref.

Descriptors: *Succession, *Rehabilitation, *Lakes, *Fisheries, *Lake Huron, *Georgian Bay, *Trout, *Fish populations, Whitefish, Cisco, Lamprey, Great Lakes, Lake trout, Alewife, Smelt, Salmon, Splake, Commerical fishing.

Data on commercial fishing catches from the 1920s to the present in Georgian Bay, Lake Huron were analyzed. The most striking changes were the near extinction of the lake trout; reductions in lake herring, deepwater ciscoes and lake whitefish; and the increase in abundance of smelt and alewife. These changes were attributed to overfishing for lake trout, lake whitefish, and deepwater ciscoes and the introduction of new species such as sea lamprey, alewife, rainbow smelt, and salmonids. In an effort to replenish the cold-water fish population, a fast growing and early maturing hybrid trout (splake = S. Salvelinus namaycush x S. fontinalis) and its backcross to lake trout were selectively bred for stocking in Georgian Bay. Splake did poorly because of low survival immediately after planting. The backcross survival after planting was better, but adult mortality was still high. Adult survival of backcross improved considerably after restrictions were placed on the commercial fishery in 1984. The first naturally produced backcross larvae were collected in 1985. (Cassar-PTT)
W89-06347

CHANGES IN THE NORTH CHANNEL FISH COMMUNITY WITH EMPHASIS ON PINK SALMON (ONCORHYNCHUS GORBUSCHA WALBAUM),
Ontario Ministry of Natural Resources, Toronto. Lake Huron Fisheries Research Unit.
For primary bibliographic entry see Field 8I.
W89-06348

SEDIMENTARY DIATOM ASSEMBLAGES AND THEIR UTILITY IN COMPUTING DIATOM-INFERRED PH IN SUDBURY ONTARIO LAKES,
Trent Univ., Peterborough (Ontario). Trent Aquatic Research Centre.
S. S. Dixit, A. S. Dixit, and R. D. Evans.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 135-148, November 21, 1988. 6 fig, 5 tab, 45 ref.

Descriptors: *Acid rain effects, *Lakes, *Sediments, *Hydrogen ion concentration, *Limnology, *Acidic water, *Diatoms, *Paleolimnology, Algae, Lake sediments, Metals.

Surface sediment diatoms from 30 Sudbury lakes were analyzed to establish a relationship between diatoms and limnological characteristics of these lakes. Factor analysis of various chemical and physical variables suggested that most of the variance was associated with the pH, pH-metal, and conductivity factors. Factor analysis of common diatom taxa indicated that the distribution of most of these diatoms was closely related to lake water pH and/or pH related factors. Regression analysis of various pH indicator assemblages with measured lake water pH also demonstrated significant relationships. Among the transfer functions used to compute diatom-inferred pH, multiple regressions using pH indicator assemblages proved to be the best. Using this method, an accuracy of about 0.3 pH unit was achieved, even for lakes which received large trace metal inputs concurrent with increase in acidity. The presence of planktonic diatoms in acidic lakes suggests that the widely accepted hypothesis that planktonic diatoms are greatly reduced in waters at pH below 5.6 is not always true. (Author's abstract)
W89-06349

SEASONAL VARIATIONS IN PHYTOPLANKTON SIZE STRUCTURE IN LAKE CROMWELL (LAURENTIAN SHIELD), QUEBEC,
Montreal Univ. (Quebec). Dept. of Biological Sciences.
I. T. Jordan, P. E. Ross, and B. Pinel-Alloul.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 167-182, November 21, 1988. 7 fig, 3 tab, 110 ref. NSERC A7766 and AO225, FCAC EO 0467.

Descriptors: *Limnoloyg, *Lakes, *Seasonal variation, *Phytoplankton, Algae, Lake Cromwell, Quebec, Water temperature, Temperature, Acidic water.

Seasonal variation in phytoplankton size classes was studied over a year in 1983-1984 in Lake Cromwell, a small, mesotrophic, slightly acidic, brown-water lake. The 2-16 micrometer algae (Classes 1 to 3) contributed > 80% of the total phytoplankton numbers throughout the sampling period and > 60% of the total biomass from August 1983 to May 1984. In early summer the 2-8 micrometer algae (Classes 1 and 2) declined steadily in relative abundance and biomass, showing minimum proportions during fall turnover, then increasing sharply to a maximum from November 1983 to June 1984, when they comprised 70-90% of the total phytoplankton abundance and 10-60% of total biomass. There was a dramatic increase in the 8-16 micrometer class (Class 3) from the end of July to October 1983, when it accounted for >45% of total phytoplankton biomass and abundance. Other size classes investigated were No. 4, 16-32; No. 5, 32-64; No. 6, 64-128; No. 7, 128-256; No. 8, 256-512; and No. 9, >512 micrometers. Classes 4 and 5 had increased abundances and biomasses in summer. Classes 6 to 9 were relatively unimportant in abundance and biomass. In multiple linear regressions between environmental parameters and size classes, temperature was always the most important variable. (Cassar-PTT)
W89-06350

EFFECTS OF REGULATED STREAM ON THE HYDROCHEMISTRY AND ZOOBENTHOS IN DIFFERENTLY POLLUTED PARTS OF THE UPPER VISTULA RIVER (SOUTHERN POLAND),
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
For primary bibliographic entry see Field 5C.
W89-06351

BENTHIC NEMATODES IN ACIDIFIED LAKES: CASE OF A NEGLECTED GRAZER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5C.
W89-06352

AERATION OF LAKE MUTEK AS A METHOD OF RECULTIVATION: RANGE OF STUDIES AND LAKE MORPHOLOGY (NAPOWIETRZANIE JEZIORA MUTEK JAKO METODA REKULTYWACJI ZAKRES BADAN I MORFOLOGIA ZBIORNIKA),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
For primary bibliographic entry see Field 5G.
W89-06356

CHANGES OF WATER CHEMISTRY INDUCED BY ARTIFICIAL AERATION OF LAKE MUTEK (ZMIANY CHEMIZMU WOD JEZIORA MUTEK POD WPLYWEM TRZYLETNIEGO SZTUCZNEGO NAPOWIETRZANIA),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06357

CHEMISTRY OF BOTTOM SEDIMENTS IN LAKE MUTEK INDUCED BY ARTIFICIAL AERATION (CHEMIZM OSADOW DENNYCH JEZIORA MUTEK PODDANEGO EKSPERYMENTOWI SZTUCKZNEGO NAPOWIETRZANIA),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06358

EFFECT OF ARTIFICIAL LAKE DESTRATIFICATION ON CHANGES OF PHYTOPLANKTON BIOMASS (WPLYW SZTUCZNEJ DESTRATYFIKACJI JEZIORA NA ZMIANY BIOMASY PLANKTONU ROSLINNEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06359

PHYTOPLANKTON OF AN ARTIFICIALLY AERATED LAKE MUTEK (PLANKTON ROSLINNY JEZIORA MUTEK PODDANEGO SZTUCZNEMU NAPOWIETRZANIU HYPOLIMNIONU),
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Zaklad Rybactwa Stawowego.
For primary bibliographic entry see Field 5G.
W89-06360

CHARACTERISTICS OF MORE IMPORTANT SPECIES OF HYDROMACROPHYTES AND THEIR BIOMASS IN A RECULTIVATED LAKE MUTEK (CHARAKTERYSTYKA WAZNIEJSZYCH GATUNKOW HYDROMAKROFITOW I ICH BIOMASY W REKULTYWOWANYM JEZIORZE MUTEK),
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Dept. of Pond Management.
For primary bibliographic entry see Field 5G.
W89-06361

BACTERIOLOGICAL WATER QUALITY OF AN ARTIFICALLY DESTRATIFIED LAKE (CZYSTOSC BAKTERIOLOGICZNA WODY JEZIORA SZTCUZNIE DESTRATYFIKOWANEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06362

MICROBIOLOGICAL STUDY OF AN ARTIFICIALLY DESTRATIFIED LAKE (MIKROBIOLOGICZNE BADANIA JEZIORA SZTUCZNIE DESTRATYFIKOWANEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
S. Niewolak.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 155-172, 1988. 4 fig, 3 tab, 52 ref. English summary.

Descriptors: *Lake restoration, *Lakes, *Water quality control, *Fisheries, *Aeration, *Phytoplankton, *Bacteria, *Eutrophic lakes, *Lake Mutek, *Poland, Destratification, Microbiological studies, Heterotrophic bacteria, Yeasts, Fungi, Algae, Zooplankton, Sediments, Bottom sediments, Lake sediments, Rainfall, Runoff, Oxygenation.

Microorganisms were studied in the bottom sediments and water column of Lake Mutek, which was artificially aerated during 1978-1980. The lake was destratified during 1979 and 1980. During these periods the changes in quantitative composition and vertical distribution of bacterioplankton, heterotrophic bacteria, and yeasts were observed. The total number of bacterioplankton varied from 61,000 to 303,432,000 cells/ml, heterotrophic bacteria from 10 to 2,300,000 cells/ml, and yeasts from 0 to 773 colonies/ml. Actinomycetes and filamentous fungi were rare and did not exceed 62 and 120 colonies/ml, respectively. During the study period the average numbers of bacterioplankton and heterotrophic bacteria decreased gradually, reaching the lowest level in 1980. Yeasts increased in number in the first year of aeration and decreased to original levels during the two subsequent years. In 1977 and 1978 physicochemical conditions favored maximal numbers of bacterioplankton, heterotrophic bacteria and yeasts in the metalimnion. In 1979 and 1980 the absence of a thermocline impaired algal stratification in the optimal radiation conditions, favoring higher numbers of these microorganisms in deeper water layers and above the bottom. Microorganisms were also less abundant in layers where zooplankton were actively feeding. Higher numbers of heterotrophic bacteria, Actinomycetes, filamentous fungi and yeasts were frequently noted after heavy rainfalls, a result of microorganisms washing in from surrounding pastures. All organisms were more numerous in bottom sediments than in water. Turbulence of sediments during aeration could have facilitated transfer of organisms from sediment to water. (See W89-06356 thru W89-06362 and W89-06364 thru W89-06365) (Cassar-PTT)
W89-06363

ZOOPLANKTON IN ARTIFICIALLY AERATED LAKE MUTEK IN THE PERIOD 1977-1980 (ZOOPLANKTON SZTUCZNIE NAPOWIETRZANEGO JEZIORA MUTEK W LATACH 1977-1980),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06364

CHANGES IN FISHERY PRODUCTION OF LAKE MUTEK (ZMIANY PRODUKCJI RYBACKEIJ JEZIORA MUTEK),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
For primary bibliographic entry see Field 5G.
W89-06365

HYDROGEN SULFIDE PRODUCTION IN BOTTOM SEDIMENTS IN THE NORTHERN AND SOUTHERN LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
For primary bibliographic entry see Field 5B.
W89-06370

MODIFIED MPN METHOD FOR COUNTING OLIGOTROPHIC BACTERIA BY USING NATURALLY OCCURRING ORGANICS,
Kyoto Univ. (Japan). Dept. of Fisheries.
K. Fukami, S. Ohara, Y. Ishida, and A. A. Mariazzi.
Nippon Suisan Gakkaishi NSUGAF, Vol. 54, No. 9, p 1659-1663, September 1988. 5 fig, 12 ref.

Descriptors: *Oligotrophy, *Heterotrophic bacteria, *Bacterial analysis, *Dissolved solids, *Most probable number test, *Lakes, Bacterial counting, Organic carbon, Chemical oxygen demand.

A MPN (most probable number) method was modified to determine the number of oligotrophic bacteria in fresh water. A series of MPN media were prepared with natural lake water by either autoclaving or filter-sterilization, and with diluted peptone solution (0.5 mg/L) as a reference. Bacterial growth-positive test tubes were judged directly by epifluorescence microscopic counting. The bacterial counts using the medium of filtered-sterilized in situ lake water was significantly higher than those obtained by autoclaved in situ lake water or peptone media. The difference in counting values between autoclaving and filter-sterilization was much larger when natural lake water media were prepared after several days' incubation under light condition. In this period, the organic carbon concentration (as COD, chemical oxygen demand) increased more than twice, mainly due to the excretion by phytoplankton. Naturally occurring dissolved organic matter, which was much suitable for the growth of autochthonous bacteria (oligotrophs) in the corresponding period, becomes one of the best media for counting the number of oligotrophic bacteria. Seasonal fluctuation of bacteria counts obtained by the present method showed a good correlation to that of chlorophyll a, suggesting that the natural population of heterotrophic bacteria was influenced by phytoplankton through its excreted organic carbon. (Author's abstract)
W89-06371

PREDICTABILITY OF CHANGE IN SHORELINE VEGETATION IN A HYDROELECTRIC RESERVOIR, NORTHERN SWEDEN,
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2I.
W89-06375

FISH SPECIES RICHNESS IN RELATION TO LAKE AREA, PH, AND OTHER ABIOTIC FACTORS IN ONTARIO LAKES,
Ontario Ministry of Natural Resources, Toronto.
For primary bibliographic entry see Field 5C.
W89-06377

MAGNITUDE OF BLUE-GREEN ALGAL BLOOMS IN A SALINE DESERT LAKE EVALUATED BY REMOTE SENSING: EVIDENCE FOR NITROGEN CONTROL,
Arizona State Univ., Tempe. Dept. of Zoology.
D. L. Galat, and J. P. Verdin.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1959-1967, November 1988. 4 fig, 4 tab, 52 ref.

Descriptors: *Cyanophyta, *Eutrophication, *Saline lakes, *Deserts, *Limnology, *Nitrogen, Remote sensing, Phytoplankton, Meromixis, Landsat, Nevada, Succession.

Seventy-six percent of the 1972-86 variability in remotely sensed maximum surface water biomass of Nodularia spumigena blooms in Pyramid Lake, Nevada, was explained by concentrations of surface water total nitrogen (TN) during the preceding winter circulation. Very large summer-autumn Nodularia blooms were recorded by Landsat subsequent to low early winter surface water TN concentrations, very low fluvial discharge, and fluvial TN loads as predicted, but contrary to predictions, also when fluvial discharge and TN loads were very high. The observed cause of large Nodularia blooms following high fluvial nitrogen influx was temporary meromixis produced by the large volume of freshwater transporting this nitrogen. Incomplete winter lake circulation reduced internal transport of hypolimnetic nitrogen to surface waters. Meromixis resulted in early stable summer thermal stratification and early depletion of epilimnetic inorganic nitrogen, followed by early and large Nodularia blooms. Variations in magnitude of historic Nodularia blooms in a saline desert lake support the generality of blue-green algal dominance in lakes with low nitrogen and high phosphorus concentrations (i.e. low N:P ratios). However, climatic forcing of fluvial discharge and lake mixing patterns were also important determinants of seasonal succession of phytoplankton to blue-greens. (Author's abstract)
W89-06378

PATTERNS IN BIOMASS AND COVER OF AQUATIC MACROPHYTES IN LAKES: A TEST WITH FLORIDA LAKES,
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
D. E. Canfield, and C. M. Duarte.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1976-1982, November 1988. 3 fig, 4 tab, 14 ref.

Descriptors: *Limnology, *Biomass, *Macrophytes, *Lakes, *Mathematical models, *Aquatic plants, Light intensity, Littoral zone, Florida, Data collections.

Data from 69 Florida lakes were used to test 15 empirical models that were developed from a worldwide database to describe the biomass and cover of aquatic macrophytes in lakes. Ten of the models failed to provide useful predictions in Florida because the models did not adequately reflect the limnological characteristics of Florida lakes. Submerged and emergent biomass in the Florida lakes was predicted by the models that estimated these parameters from the areal cover of submerged and emergent vegetation. Total macrophyte cover in Florida lakes could be predicted from a model based on lake size, annual irradiance at the surface, and the mean annual irradiance within the mean depth of the lake. Even the best models, however, overestimated submerged plant biomass and cover in highly colored (>400 Pt-Co units) lakes and lakes with steep (slope > 15%) littorals. The influence of light (quantity and quality) and littoral slope on the abundance of aquatic macrophytes apparently needs additional research before improved empirical models can be developed for lakes located in limited geographic regions. (Author's abstract)
W89-06379

TRACE METAL CONCENTRATIONS IN SOME KASHMIR HIMALAYAN LAKES,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
For primary bibliographic entry see Field 5B.
W89-06386

WATERSHED VS IN-LAKE ALKALINITY GENERATION: A COMPARISON OF RATES USING INPUT-OUTPUT STUDIES,
NSI Technology Services Corp., Corvallis, OR.
For primary bibliographic entry see Field 5B.
W89-06387

TEMPORAL AND SPATIAL TRENDS IN METAL LOADS TO SEDIMENTS OF LAKE SIMCOE, ONTARIO,
Department of Fisheries and Oceans, Owen Sound (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5B.
W89-06391

DER WETLANDS PROTECTION ACTION PLAN,
Pennsylvania Dept. of Environmental Resources, Harrisburg.
For primary bibliographic entry see Field 6E.
W89-06406

BIOLOGICAL INDICATION OF TROPHY AND POLLUTION OF RUNNING WATERS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.). Dept. of Limnology.
For primary bibliographic entry see Field 5A.
W89-06416

HANDY IMPACT CORER FOR SAMPLING LAKE SURFACE SEDIMENT,
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 7B.
W89-06436

PHYTOPLANKTON COMMUNITY OF A EUTROPHIC RESERVOIR,
Essex Univ., Colchester (England). Dept. of Biology.
M. M. Abdul-Hussein, and C. F. Mason.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 265-277, November 30, 1988. 8 fig, 2 tab, 19 ref, append.

Descriptors: *Reservoirs, *Eutrophic lakes, *Phytoplankton, *Species composition, Diatoms, Chlorophyta, Cyanophyta, Water temperature, Hydrogen ion concentration, Biomass, Wind, Seasonal variation, Succession.

The dynamics of the phytoplankton community of a eutrophic reservoir are described for a two-year period. Fifty-eight species were recorded, 25 of them common. Bacillariophyta dominated during the winter and early spring and Chlorophyta during late spring, to be replaced by a bloom of Cyanophyta. The mean and peak biomass of phytoplankton was 8.6 mg/L and 40.8 mg/L in 1981, and 8.3 mg/L and 37.6 mg/L in 1982. Temperature accounted for 67.3% and pH for 8% of the variation in total phytoplankton biomass over the two-year period, using a multiple regression technique. Both horizontal and vertical patchiness, measured as an index of mean crowding, were recorded in the reservoir. Horizontal aggregations were associated with spring blooms of Chlorophyta and summer blooms of Cyanophyta, while vertical aggregations were most marked during the summer bloom of Cyanophyta. Concentrations of phytoplankton were influenced by wind, the prevailing southwesterly wind accumulating algae in the northeasterly arm of the reservoir during much of the year. (Author's abstract)
W89-06437

PALEOECOLOGICAL RECONSTRUCTION OF CHANGES IN THE PRODUCTIVITY OF A SMALL, MEROMICTIC LAKE IN SOUTHERN ONTARIO, CANADA,
Aquatic Research and Ecological Consultants, Mississauga (Ontario).
M. Rybak, and M. Dickman.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 293-306, November 30, 1988. 10 fig, 37 ref.

Descriptors: *Meromictic lakes, Eutrophication, *Paleolimnology, *Productivity, *Stratigraphy, *Ontario, *Canada, Lake sediments, Pigments, Diatoms, Land clearing, Deforestation, Chlorophyll, Aquatic bacteria, Cyanophyta, Crawford Lake.

Some aspects of the paleoproductivity of meromictic Crawford Lake, near Toronto, are inferred from a study of its sedimentary pigments and diatoms. Several stages of lake development are observed over the 35 cm-deep sediment core removed from the center of Crawford Lake. Evidence of changes in lake productivity during the last 300 years was reflected by significant stratigraphic sediment pigment changes which were associated with European settlement in the Crawford Lake watershed and recent alterations associated with the area's operation by the Conservation Authority (1969-present). One of the most important factors correlated with paleoproductivity was land clearance (mainly logging of white oak and pine). Deforestation during the last century is correlated with an increase in the amount of algal pigments deposited in the lake's sediments during

the 1800's. During the last 10 years a striking increase in the accumulation of chlorophyll derivatives was observed. This is correlated with a dramatic increase in the number of visitors to the lake. Stratigraphic changes in the ratio of cyanobacterial to phototrophic bacterial pigment accumulation are used to infer changes which occurred during the shift from mesotrophy to eutrophy in Crawford Lake. (Author's abstract)
W89-06438

DISTRIBUTION PATTERN OF THE DINOFLAGELLATE CERATIUM HIRUNDINELLA (O.F. MULLER) BERGH IN A RESERVOIR,
Ehime Univ., Matsuyama (Japan). Dept. of Environment Conservation.
Z. Kawabata, and H. Kagawa.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 319-325, November 30, 1988. 5 fig, 13 ref.

Descriptors: *Distribution patterns, *Dinoflagellates, *Ceratium, *Reservoirs, Population dynamics, Water quality, Japan, Environmental gradient, Water temperature.

Horizontal distribution of the dinoflagellate Ceratium hirundinella in the Ishitegawa Reservoir, Ehime Prefecture, Japan, was investigated. Water quality was also surveyed. It was observed that the population of C. hirundinella exponentially decreased in number from the head of the reservoir to the dam site. Further investigation proved that C. hirundinella initiated growth at the head of the reservoir, and later gradually expanded downstream. It was found during the period of increase in water temperature that the cell density of C. hirundinella at the uppermost station increased exponentially. (Author's abstract)
W89-06439

SPATIAL, TEMPORAL AND STORM RUNOFF-RELATED VARIATIONS IN PHYTOPLANKTON COMMUNITY STRUCTURE IN A SMALL, SUBURBAN RESERVOIR,
George Mason Univ., Fairfax, VA. Dept. of Biology.
J. J. Edson, and R. C. Jones.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 353-362, November 30, 1988. 8 fig, 1 tab, 16 ref.

Descriptors: *Species composition, *Storm runoff, *Reservoirs, *Phytoplankton, Seasonal variation, Spatial distribution, Principal Component Analysis, Virginia.

Phytoplankton abundance and community structure were determined routinely over an annual period and intensively during two storm-runoff events in a small suburban reservoir in northern Virginia. Traditional graphical techniques and a multivariate approach (Principal Components Analysis) were used to demonstrate a seasonal pattern of phytoplankton succession with greens and blue-greens dominant in summer, diatoms and chrysophytes in spring and fall, and cryptophytes in winter. Spatial variations were minor over horizontal and vertical dimensions during spring mixis, but depth variations were substantial during summer stratification. Storm runoff had little effect on phytoplankton composition during the stable summer period, but was associated with a substantial perturbation in community structure during the spring to summer transition. (Author's abstract)
W89-06440

PHOSPHORUS AND NITROGEN EXCRETION RATES OF ZOOPLANKTON FROM THE EUTROPHIC LOOSDRECHT LAKES, WITH NOTES ON OTHER P SOURCES FOR PHYTOPLANKTON REQUIREMENTS,
Limnologisch Inst., Nieuwersluis (Netherlands). Vijverhof Lab.
P. J. Den Oude, and R. D. Gulati.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 379-390, November 30, 1988. 7 fig, 2 tab, 39 ref.

Descriptors: *Excretion, *Nutrient requirements, *Phytoplankton, *Limnology, *Zooplankton, *Nitrogen, *Phosphorus, *Eutrophic lakes, Seasonal variation, Water temperature, Loosdrecht lakes, Netherlands, Cycling nutrients, Biomass, Species composition.

Phosphorus and nitrogen excretion rates by zooplankton communities from two eutrophic and shallow Dutch lakes were measured. The variations in excretion rates in the lakes (May-October) were caused mainly by fluctuation in zooplankton biomass. Mean summer excretion rates (June-September) were 2.4 and 0.9 microgram PO4-P/L/d in Lake Loosdrecht and Lake Breukeleveen, respectively. This difference between the lakes was caused mainly by the lower zooplankton biomass in Lake Breukeleveen. The excretion of 2.4 microgram PO4-P/L/d compared with the calculated P-demand of phytoplankton of 8.0 microgram PO4-P/L/d is substantial in the summer and far more important than the external P-supply of 0.4 microgram P/L/d and sediment release of 0.5 microgram P/L/d. Both temperature and composition of zooplankton affected the weight specific excretion rates of the zooplankton community. The weight specific community excretion rates of P and N increased with temperature (exponential model); 1-8 microgram PO4-P/mg zooplankton-C/d and 5-42 microgram NH3-N/mg zooplankton-C/d (10-20 C). (Author's abstract)
W89-06441

ACIDIFICATION OF THREE MOORLAND POOLS IN THE NETHERLANDS BY ACID PRECIPITATION AND EXTREME DROUGHT PERIODS OVER SEVEN DECADES,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
For primary bibliographic entry see Field 5C.
W89-06442

EFFECTS OF TURBIDITY ON LIFE HISTORY PARAMETERS OF TWO SPECIES OF DAPHNIA,
Orange Free State Univ., Bloemfontein (South Africa).
S. Scholtz, M. T. Seaman, and A. J. H. Pieterse.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 177-184, October, 1988. 5 fig, 2 tab, 29 ref.

Descriptors: *Daphnia, *Turbidity, *Life history studies, Fish, Predation, Seasonal variation, Aquatic populations, Succession, Temperature effects, Nutrition.

Life table experiments were carried out in a range of turbidities on D. pulex, representing a 'clear-water', and on D. barbata, representing a turbid-water species. In contrast to predictions based on seasonal occurrence patterns, D. pulex had a higher intrinsic rate of increase over most of the turbidity range than D. barbata. Consistent differences in life history between the two species were found, but life history characteristics were rather insensitive to turbidity levels. Although turbidity per se appears to have little direct effect on life history parameters, it could influence the seasonal succession of these two species by interacting with other factors. It is suggested that visual predation by fish rather than turbidity per se probably influenced the seasonality of Daphnia species. During the warmer months, selective removal of D. pulex by visually foraging fishes may allow D. barbata to gain dominance. Effects of temperature and nutrition also merit further study. (Author's abstract)
W89-06443

NOTE ON LAKE GOANG, AN UNUSUAL ACID LAKE IN FLORES, INDONESIA,
Queen Mary Coll., London (England). Centre for Research in Aquatic Biology.
J. Green, and H. Kramadibrata.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 195-198, October, 1988. 1 fig, 1 tab, 15 ref.

Descriptors: *Limnology, *Lakes, *Acidic water, *Indonesia, Lake Goang, Hydrogen ion concentration, Asphalt, Flores Island, Aquatic life, Chemical properties, Plankton, Oil slicks.

Lake Goang has a pH of 2.5. Associated with this low pH are high concentrations of sulfate, chloride, iron and aluminum. There are no fish in the lake. A single species of Heterococcales was found in the phytoplankton. The zooplankton consists of one species of rotifer and a stalked species of Vorticella. The shallow water fauna consists of two species of nematodes, at least two larval Diptera, one trichopteran, a zygopteran, a small crab (Sundatelphusa) and a cyclopoid copepod (Paracyclops). During January an oily slick appears and is deposited as asphalt around the shore of the lake. The overall indications are that this asphalt has biological origins; the seasonal occurrence may involve a movement of the thermocline, allowing an upwelling of hydrocarbons from an area normally within the hypolimnion. (Author's abstract)
W89-06444

NATURAL COMMUNITY BIOASSAYS TO DETERMINE THE ABIOTIC FACTORS THAT CONTROL PHYTOPLANKTON GROWTH AND SUCCESSION,
Amsterdam Univ. (Netherlands). Dept. of Aquatic Ecology.
E. Van Donk, A. Veen, and J. Ringelberg.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 199-210, October, 1988. 5 fig, 5 tab, 35 ref.

Descriptors: *Ecosystems, *Lakes, *Bioassays, *Limnology, *Phytoplankton, *Succession, *Growth rates, *Bioassay, Nutrients, Phosphorus, Phosphates, Trace metals, Chelating agents, Fungi, Parasites, Seasonal variation, Lake Maarsseveen, Algae, Chrysophyta, Diatoms, Chlorophyta, Netherlands.

The successional patterns of the dominant phytoplankton species in Lake Maarsseveen (Netherlands) were very similar in 1980 and 1981. In December/January the diatoms Stephanodiscus hantzschii, S. astraea and Asterionella formosa dominated the algal community. Fragilaria crotonensis came to dominance in March/April, followed by the chrysophyte Dinobryon divergens and the diatom Cyclotella comta in May/June. A second appearance of D. divergens was observed in July/August, followed in 1980 by F. crotonensis and a third small increase of D. divergens. In both years S. astraea and S. hantzschii started to grow again in November/December. Cryptophyceae and Chlorophyta were present throughout the year, but did not show a distinct succession. Natural community bioassays, performed under natural light and temperature conditions in a newly developed outdoor bioassay apparatus, showed that phosphate was the major nutrient limiting the growth rate of the phytoplankton. From January-June, during the decline in P concentration, the diatoms became successively phosphate limited in the sequence: S. hantzschii, S. astraea, F. crotonensis, A. formosa and C. comta. Light limitation was probably the major cause of the relatively late start of F. crotonensis in early spring. D. divergens, increasing after the diatoms from June-September, was stimulated by the addition of a chelator (EDTA). The chelator might stimulate the formation of trace metal species favoring their uptake (e.g. iron). The patterns of succession of the diatoms from January-June and from July-December were to a large extent symmetrical. The controlling factors followed opposite trends: declining P concentrations with increasing irradiance from winter till spring and increasing P with decreasing irradiance from summer till late winter. A. formosa was sometimes heavily infected by the parasitic chytrid fungus Zygorhizidium planktonicum. The infection may have been responsible for the cyclic wax and wane of Asterionella with intervals of 2-3 months, reductions in Asterionella perhaps favoring increases in other diatom species. (Author's abstract)
W89-06445

IMPACT OF BIOLOGICAL ACTIVITY ON DETRITUS TRANSPORTED IN THE LOWER RIVER RHINE: AN EXERCISE IN ECOSYSTEM ANALYSIS,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands).
W. Admiraal, and B. Van Zanten.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 215-225, October, 1988. 10 fig, 2 tab, 44 ref.

Descriptors: *Biodegradation, *Rivers, *Ecosystems, *Carbon budget, *Detritus, *Organic matter, Phytoplankton, Aquatic bacteria, Mineralization, Water pollution, Netherlands, Rhine River.

Published data were used to construct a tentative carbon budget for the ecosystem of the lower river Rhine and its sedimentation areas in The Netherlands. It is estimated that 287,000,000 kg C/y of particulate organic material is transported by the river, and 100,000,000 kg C/y of this material is deposited in the delta. Phytoplankton and nitrifying bacteria seem to contribute significantly to the carbon budget, by producing about 78,000,000 kg C/y. The mineralization in the water (estimated from routine determinations of biological oxygen demand and from in situ diurnal fluctuations of oxygen) and in the bottom (estimated from the denitrification rates in the delta, from the production rate of methane and from overall oxygen consumption) is shown to degrade about 50% of the carbon input plus autochthonous production. The carbon budget and oxygen regime in the lower Rhine suggest that after decades of severe organic pollution the river has more or less resumed the normal, slightly heterotrophic state of a large lowland river. (Author's abstract)
W89-06447

MICRO-DISTRIBUTION OF AQUATIC MACROINVERTEBRATES IN THE WYE RIVER SYSTEM: THE RESULT OF ABIOTIC OR BIOTIC FACTORS,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
S. J. Ormerod.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 241-247, October, 1988. 2 tab, 65 ref.

Descriptors: *Distribution patterns, *Rivers, *Limiting factors, *Macroinvertebrates, Aquatic habitats, Wye River, Wales, Species composition, Ecological distribution, Stream biota, Riffles, Catchment areas.

Macroinvertebrates were sampled from three habitats at each of 45 sites in the catchment of the Welsh River Wye. Micro-distribution patterns between three habitat types were assessed for those species which occurred most commonly. Of the 53 taxa for which analysis was possible, 20 showed a significant association with habitat type. Eleven occurred mostly in margins, 8 mostly in riffles, and one in flats (depositing reaches). Twenty-one taxa, including 11 additional to those showing significant associations, showed significant differences between habitats in their relative abundance. Ten were most abundant in margins, 8 in riffles and 3 in flats. Among the factors possibly responsible for these habitat preferences are the role of competition and resource petitioning, habitat availability, physical tolerances, resource patchiness and predator-prey interactions. (Author's abstract)
W89-06449

PLANKTONIC BLOOM-FORMING CYANOBACTERIA AND THE EUTROPHICATION OF LAKES AND RIVERS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.). Dept. of Limnology.
C. E. W. Steinberg, and H. M. Hartmann.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 279-287, October, 1988. 82 ref.

Descriptors: *Eutrophication, *Lakes, *Rivers, *Plankton, *Cyanophyta, *Population dynamics, Turbulent flow, Water temperature, Hydrogen ion concentration, Light penetration, Enrichment, Physical properties, Meromictic lakes, Nutrients.

Eutrophication of water bodies involves the enrichment of plant nutrients, often followed by significant shifts in the phytoplankton towards Cyanobacteria. When comparing different aquatic systems, even with similar nutrient contents and in the same climatic region, inverse deductions are not valid; i.e. (a) the presence of Cyanobacteria does not necessarily indicate eutrophic conditions, or (b) eutrophic or even polytrophic conditions do not necessarily support cyanobacterial development. Above a threshold of 10 microgram/L total P, the development of Cyanobacteria can be described by physical factors, e.g. water column stability. By characterizing different forms of turbulence, the presence or absence of Cyanobacteria in lakes and rivers can be predicted. When the turbulence of the water column is rather low, as it is in sheltered or meromictic lakes, Cyanobacteria can build up dense populations. In nutrient poor systems, species of Oscillatoria and (seldom) Aphanizomenon are dominating. If the turbulence of the water column is high (mixing depth much greater than eutrophic depth) or the mixing pattern is irregular, as in slowly flowing or regulated rivers, Cyanobacteria are outcompeted. In the presence of frequent or permanent turbulence, but with mixing depths lower or not much greater than the eutrophic zone (as in the case of shallow, unstratified lakes, mostly eutrophic or even hypertrophic), Cyanobacteria can outgrow normally dominant r-strategists under conditions of low N:P ratios, high water temperatures, pH >9.0 or low light availability. If turbulence is comparatively great (10 to < or = 15 m) and stable for a longer period of time, some Cyanobacteria are able to adapt. (Author's abstract)
W89-06450

TEMPORAL SENSITIVITY OF APHANIZOMENON FLOS-AQUAE DOMINANCE: A WHOLE-LAKE SIMULATION STUDY WITH INPUT PERTURBATIONS,
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
O. Varis.
Ecological Modelling ECMODT, Vol. 43, No. 3/4, p 137-153, November, 1988. 10 fig, 5 tab, 19 ref.

Descriptors: *Simulation analysis, *Model studies, *Limnology, *Aphanizomenon, *Lakes, Algae, Phytoplankton, Mathematical models, Water temperature, Irradiance, Biomass, Sensitivity analysis, Nutrients.

The temporal sensitivity of the competitive ability of N-fixing blue-green algae, mainly Aphanizomenon flos-aquae, was studied with a whole-lake simulation model. The model input values for the P and N loads, water temperature and irradiance were perturbed separately for every 4th day throughout one year. The aim was to find out whether 10% perturbation in the inputs on different instants would cause output variations of different character and magnitude. The simulation was realized with a deterministic 15th-order lumped parameter model describing the P and N dynamics and the N-fixing cyanobacteria and other phytoplankton of Lake Kuortaneenjarvi, Finland. Sensitivity showed a very rapid increase in spring, followed by an exponential decline. Limiting factors and factors connected with ecological competition differed profoundly in their effect on algal production. An immediate collinear response in output was evoked by changes in limiting factors while a mirror-image type response with lags in competing algal groups was evoked by ecological factors. The response of cyanobacteria to the perturbations was 2-5 times as great as that of the other algae. (Author's abstract)
W89-06451

OKEFENOKEE MARSHLAND BEFORE, DURING AND AFTER NUTRIENT ENRICHMENT BY A BIRD ROOKERY,
Georgia Univ., Athens. Inst. of Ecology.
J. D. Oliver, and T. Legovic.
Ecological Modelling ECMODT, Vol. 43, No. 3/4, p 195-223, November, 1988. 9 fig, 6 tab, 48 ref.
NSF Grants BSR 8114823 and BSR 8215587.

Descriptors: *Nesting, *Wetlanus, *Swamps, *Marshes, *Nutrients, *Enrichment, Model studies, *Birds, Macrophytes, Fish, Detritus, Plankton, Ecosystems.

Field measurements and data from the literature were used to construct a trophic model of Okefenokee Swamp marshland. Seasonal data were used to check dynamics of the model before, during, and after simulated nutrient input from wading bird guano. The model gives reasonable estimates of the effects of enrichment on benthic detritus, aquatic macrophytes and phytoplankton, and conservative estimates of the increase of zooplankton and fish stocks. Simulated levels of the above components decreased toward nominal states after simulated abandonment by birds, and the rates of decrease generally followed field trends that were measured. The model indicates that nesting wading birds can have considerable affects on aspects of an aquatic ecosystem that are not normally associated with them (e.g. benthic detritus and fish). Significant links between components of aerial and aquatic systems are thus brought to light. (Author's abstract)
W89-06453

VERTICAL DISTRIBUTION OF BROWN TROUT (SALMO TRUTTA) AND PERCH (PERCA FLUVIATILIS) IN AN ACIDIFIED LAKE,
Hedmark County Environmental Administration, Hamar (Norway).
For primary bibliographic entry see Field 5C.
W89-06493

CHANNEL HYDRAULICS, HABITAT USE, AND BODY FORM OF JUVENILE COHO SALMON, STEELHEAD, AND CUTTHROAT TROUT IN STREAMS,
Weyerhaeuser Co., Tacoma, WA.
P. A. Bisson, K. Sullivan, and J. L. Nielsen.
Transactions of the American Fisheries Society TAFSAI, Vol. 117, No. 3, p 262-273, May 1988. 2 fig, 3 tab, 55 ref.

Descriptors: *Water currents, *Chemical morphology, *Fish, *Channels, *Streamflow, Juvenile growth stage, Salmon, Trout, Streams, Ecology, Riffles, Water depth, Hydraulics.

Habitat use by juvenile coho salmon Oncorhynchus kisutch, steelhead Salmo gairdneri, and the coastal subspecies of cutthroat trout Salmo clarki clarki in small streams in western Washington was influenced by hydraulic characteristics of different types of channel units. Coho salmon preferred pools with average velocities less than 20 cm/s; very few fish were found in riffles with high current velocities. Steelhead occurred in riffles and also utilized deep pools with relatively high velocities along the center of the channel. Cutthroat trout were intermediate between coho salmon and steelhead in their use of swiftly flowing habitats. Variation in body shape and fin size among the three species generally fit the predicted morphologies that would be favored in different locations within the channel. Coho salmon possess a deep, laterally compressed body with large median and paired fins. These features are believed to facilitate rapid turns and quick but transient burst swimming. Steelhead possess a more cylindrical body shape with short median fins and relatively large paired fins, attributes that appear well adapted to holding a position in swift water. The cutthroat trout's lack of morphological adaptation to either fast or slow water may help to explain why this species is dominated by coho salmon and steelhead in areas of sympatry. (Author's abstract)
W89-06507

EFFECTS OF MUD VEGETATION ON THE NUTRIENT CONDITION OF FLOOD-PLAIN LAKES,
Jozsef Attila Univ., Szeged (Hungary). Dept. of Botany.
I. Bagi.
Aquatic Botany AQBODS, Vol. 32, No. 4, p 321-328, December 1988. 3 fig, 1 tab, 20 ref.

Descriptors: *Limnology, *Mud, *Vegetation, *Nutrients, *Flood plains, *Lakes, Spatial distribution, Salts, Zones, Nitrogen, Nitrates, Phosphorus, Potassium, Reservoirs.

The horizontal distribution of salts and nutrients in the soil of flood-plain lakes plays a role in the formation of the vegetational zones developing on the bottom. The mud vegetation has a significant influence on the distribution of nutrients. An investigation was undertaken to demonstrate the rela-

tionships between the mud vegetation and soil data for a flood plain lake along the Koros River in Hungary, with special regard to water-soluble salts and nutrients. The available nitrogen, nitrate nitrogen, phosphorus, and potassium contents in the soil with a high degree of vegetation cover were found to be essentially below the expected values. These nutrients showed decreases of 22.2, 48.5, 44.5, and 31.4%, respectively. Nutrients released from sediment and dissolved in water may cause deterioration of the water quality. The nutrients dissolved in the water are primarily utilized by algae, while those remaining in the sediment are utilized mainly by bacteria. This takes place at a time of high water temperature, when there is the greatest danger that the water will become temporarily anaerobic. The annual mud vegetation developing on the bottom of the lake during late summer and autumn takes up the easily mobilizable nutrients. In the interests of the effective handling of shallow reservoirs, studies on the annual mud vegetation may have a practical significance, owing to the role it plays in decreasing the nutrient content of the sediment. (Doria-PTT)
W89-06532

FISH COMMUNITIES AND ENVIRONMENTAL CHARACTERISTICS OF TWO LOWLAND STREAMS IN COSTA RICA,
J. Burcham.
Revista de Biologia Tropical RBTCAP, Vol. 36, No. 2A, p 273-285, November 1988. 5 fig, 5 tab, 35 ref.

Descriptors: *Costa Rica, *Fish food organisms, *Streams, *Trophic level, *Ecological effects, *Fish behavior, Food habits, Fish, Forests, Pastures, Population density, Diatoms, Light intensity, Land use.

Fish community structure was studied in a forested stream and a stream surrounded by pasture in the Atlantic lowlands of Costa Rica during the dry season from January to May, 1985. Fishes were assigned to 6 consumer guilds (omnivore, terrestrial insectivore, terrestrial herbivore, algivore, carnivore, diatom specialist) based on the primary food in the diet. Selected physical and chemical measurements were made to identify differences in the two stream environments that may influence the type of food base. The overall trophic structure of the fish communities did not differ greatly (similarity index = 0.40 AIDN analysis), but the largest proportion of each community belonged to only one guild. The greatest abundance of species in the forest stream were terrestrial insectivores while the greatest abundance in the pasture stream were diatom specialists. Higher maximum temperatures and greater abundances of invertebrates and periphyton were observed in the pasture stream. Substrate type differed between the two streams and may interact with light levels to influence the type of food resources. (Author's abstract)
W89-06535

COMPOSITION AND DYNAMICS OF ZOOPLANKTON AND ZOOBENTHOS IN LAKE SARYKAMISH (SOSTAV I DINAMIKA ZOOPLANKTONA I ZOOBENTOSA OZERA SARYKAMYSH),
Akademiya Nauk Uzbekskoi SSR, Nukus. Inst. Estestvennykh Nauk.
For primary bibliographic entry see Field 5C.
W89-06558

EFFECT OF HIGHER AQUATIC PLANTS ON MICROBIOLOGICAL INDEXES OF WATER QUALITY IN THE PRESENCE OF DECOMPOSED ORGANIC MATTER IN SUSPENSION (VLIYANIE VYSHIKH VODNYKH RASTENII NA MIKROBIOLOGICHESKIE POKAZATELI KACHESTVA VODY PRI DESTRUKTSII RASTVORENNOGO ORGANICHESKOGO VESHCHESTVA),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
V. M. Yakushin.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 3, p 45-47, 1987. English summary.

Descriptors: *Aquatic plants, *Decomposing organic matter, *Water quality, *Detritus, Chemical properties, Organic matter, Microbiological studies.

A study was conducted to examine the process of mineralization of decomposing organic matter in the presence of higher aquatic plants. Boats with sand in the bottom were used as model water courses and were filled with water from a Kiev reservoir. The water was kept flowing at 1 m/sec. Decomposing organic materials were added as an organic mineral mixture containing 50 mg peptone and sugar and 20 mg KH2PO4/L water. Plants tested included Elodea and duckweed. The presence of the plants resulted in an increased oxidation of the dissolved organic matter and a decrease in the negative effects of the organic matter on the microbiological and hydrochemical indices of water quality. (Peters-PTT)
W89-06559

CORRELATION BETWEEN PHYTOPLANKTON PRODUCTION AND ORGANIC MATTER DECOMPOSITION IN THE DANUBE, THE SASYK-DANUBE CANAL, AND THE SASYK RESERVOIR (SOOTNOSHENIE PRODUKTSU FITOPLANKTONA I DESTRUKTSII ORGANICHESKOGO VESHCHESTVA V DUNAI, KANALE DUNAI-SASYK I SASYKSKOM VODOKHRANILISHCHE),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
N. A. Davidovich.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 3, p 96-99, 1987. 3 tab, 5 ref. English summary.

Descriptors: *Biodegradation, *Phytoplankton, *Danube River, *Danube-Sasyk canal, *Sasyk Reservoir, *Organic matter, Productivity, Degradation, Euphotic zone, Water depth.

The average values (for July-August) of phytoplankton production and organic matter decomposition, were determined for the Solomonov arm of the Danube, the Danube-Sasyk canal and the Sasyk reservoir where water is characterized by increased muddiness. The production-decomposition ratio per 1 sq m of the surface and in the euphotic zone was analyzed. The primary plankton production and organic matter decomposition are presented according to their distributions by depth. (Author's abstract)
W89-06562

WATER QUALITY CHARACTERISTICS IN ELECTRO-DAM RESERVOIRS (OSOBENOSTI FORMIROVANIYA KACHESTVA VODY V VODOKHRANILISHCHAKH ENERGOKOMPLEKSOV),
Ukrainskii Nauchno-Issledovatel'skii Inst. Gidroproekt, Kharkov (USSR).
V. I. Sebast'yanov.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 10-16, 1987. 1 fig, 20 ref. English summary.

Descriptors: *Dam effects, *Hydroelectric plants, *Water temperature, *Water quality, *Reservoirs, Flow rates, Dissolved oxygen, Self-purification.

Elevation of the water temperature accompanied by high flow rates and turbulent mixing in reservoirs created by hydroelectric dams decreases the water bloom intensity and results in high oxygen saturation of all water levels during the entire year. It also results in more intensive autopurification processes. (Author's abstract)
W89-06563

INTENSITY OF PHYTOPLANKTON PHOTOSYNTHESIS AT VARIOUS WATER DEPTH LEVELS (INTENSIVNOST' FOTOSINTEZA FITOPLANKTONA NA RAZLICHNYKH GLUBINAX FOTICHESKOI ZONY),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
V. I. Shcherbak, and M. I. Kuz'menko.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 22-26, 1987. 1 fig, 2 tab, 7 ref. English summary.

Descriptors: *Photosynthesis, *Phytoplankton, *Water depth, *Kiev Reservoir, *Limnology, Primary productivity, Radiochemical analysis, Algae, Vertical distribution.

The primary production of the dominant phytoplankton species was studied for its effect on the vertical distribution of the Kiew Reservoir production. Radioautography showed that both abiotic factors which determine the vertical distribution of the primary production and the algae species composition is of great importance. (Author's abstract)
W89-06565

DETERMINATION OF THE DECOMPOSITION OF ORGANIC MATTER IN THE BOTTOM SEDIMENTS OF WATER BODIES (OPREDELENIE DESTRUKTSU ORGANICHESKOGO VESHCHESTVA B DONNYKH OTLOZHENIYAKH VODOEMOV),
Akademiya Nauk SSSR, Borok. Inst. Biologii Vnutrennykh Vod.
A. N. Dzyuban.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 30-35, 1987. 6 fig, 1 tab, 9 ref. English summary.

Descriptors: *Detritus, *Decomposing organic matter, *Sediments, Bottom sediments, Aerobic conditions, Chemical oxygen demand, Field tests, Sampling.

Several techniques have been developed which permit the determination of the aerobic destruction of the organic matter in bottom sediments of water bodies. It is necessary to observe natural conditions in field experiments, to choose the time period for sample exposure based on the ecological environment, and to take into account the chemical oxidation rates. (Author's abstract)
W89-06566

ROLE OF MEIOFAUNA IN THE BENTHOS COMMUNITIES IN VARIOUS LAKES IN LATGALIA (ROL' MEIOFAUNY V BENTOSNOM SOOBSHCHESTVE RAZNOTIPNYKH OZER LATGALII),
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
For primary bibliographic entry see Field 5C.
W89-06567

CONCEPTUAL FUNDAMENTALS, PROSPECTS AND PROBLEMS OF PERSONNEL FOR HYDROBIOLOGICAL STUDIES (KONTSEPTUAL'NYI OSNOVY PERSPEKTIVNYE ZADACHI I VOPROSY KADROVOLO OBESPECHENIYA GIDROBIOLOGICHESKIKH ISSLEDOVANII),
Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
G. G. Vinberg.
Gidrobiologicheski Zhurnal GBZUAM, Vol. 24, No. 3, p 3-30, 1988. English summary.

Descriptors: *Data collections, *USSR, *Lakes, *Education, *Training, *Hydrobiology, Ecological distribution, Universities, Information retrieval, Scientific personnel.

Four aspects of hydrobiology in the USSR are reviewed: (1) the study of freshwater as a component of the biosphere; (2) fundamentals in the determination of the bioenergetic balance of lake ecosystems; (3) determination and fundamentals of the program 'Productivity and Preservation of the USSR's Internal Waters (Program POB)'; and (4) the development of hydrobiology personnel by the biological colleges in USSR universities. (Peters-PTT)
W89-06569

EXTRACELLULAR PHYTOPLANKTON PRODUCTION AND METHODS OF ITS STUDY (VNEKLETOCHNAYA PRODUKTSIYA FITO-

PLANKTONA I METODY EE ISSLEDOVANIYA),
Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
V. V. Bul'on.
Gidrobiologicheski Zhurnal GBZUAM, Vol. 24, No. 3, p 64-73, 1988. 3 fig, 3 tab, 39 ref. English summary.

Descriptors: *Phytoplankton, *Photosynthesis, *Organic matter, *Bacteria, *Radiochemical analysis, Radioisotopes, Filtration, Plankton, Productivity.

A modification of the radiocarbon method which consists of the step-like filtration of samples with a labelled plankton through memberane filters of different densities has been developed and tested. The modification increased the accuracy of determining phytoplankton production and can be used to estimate the rate of transformation of dissolved photosynthesis products into the bacterial fraction of suspended organic matter. (Author's abstract) W89-06571

BYELORUSSIAN SCHOOL OF HYDROBIOLOGISTS AND ITS ACHIEVEMENTS (BELORUSSKAYA SHKOLA GIDROBIOLOGOV I EE DOSTIZHENIYA),
Akademiya Navuk BSSR, Minsk.
For primary bibliographic entry see Field 9A.
W89-06573

PLANT-SOIL-WATER RELATIONSHIPS IN LAS VEGAS WASH,
Bureau of Reclamation, Boulder City, NV. Lower Colorado Region.
For primary bibliographic entry see Field 2G.
W89-06624

DECAYING LAKES: THE ORIGINS AND CONTROL OF CULTURAL EUTROPHICATION,
For primary bibliographic entry see Field 5G.
W89-06629

NATIONAL SURFACE WATER SURVEY: EASTERN LAKE SURVEY (PHASE I--SYNOPTIC CHEMISTRY)--QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-06642

RECOVERY OF CANADIAN LAKES FROM ACIDIFICATION,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5G.
W89-06681

CHEMICAL AND BIOLOGICAL FEATURES OF POORLY BUFFERED IRISH LAKES,
Foras Forbartha, Dublin (Ireland).
J. J. Bowman.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 46-63. 5 fig, 6 tab, 12 ref.

Descriptors: *Lakes, *Chemical properties, *Biological properties, *Acid rain effects, *Ireland, Alkalinity, Acidic water, Hydrogen ion concentration, Species diversity, Algae, Zooplankton, Macroinvertebrates, Fish, Baseline studies.

A significant number of small Irish lakes have poorly-buffered waters and thus are sensitive to artificially-acidified rain. The chemistry and biology of four such lakes, alkalinity range 4-7 mg calcium carbonate/L, two near the east coast and two in the west, were studied over a two-year period. The chemistry of the east-coast lakes was influenced by atmospheric inputs of hydrogen ion and sulfate and by humic acids, whereas the west-coast lakes appeared to be largely influenced by natural inputs of acidity. One lake in each area (Maumwee Lough in the west and Glendalough Lake in the east) was examined biologically. Two hundred thirty-one planktonic algal taxa, mostly Chlorophyceae, were recorded in Maumwee Lough compared to 108 in Glendalough Lake. A greater diversity of zooplankton was noted in the west-coast lake. The littoral macroinvertebrate population in Maumwee Lough, dominated by Caenis moesta, was consistent with that of a lake unimpacted by acidity while that of the east-coast lake was typical of a lake under acid stress. Salmon, trout, minnows, and eels were present in the Maumwee system while trout and minnows only were taken in a survey of fish stocks in the Glendalough system. The biological and chemical characteristics of Maumwee Lough provide a baseline for assessing the impact of acid rain on other areas. (See also W89-06680) (Author's abstract) W89-06685

ACIDIFICATION PROBLEMS OF FRESHWATERS: TROPHIC RELATIONSHIPS,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 5C.
W89-06686

DEVELOPMENT OF THE ACID LAKE GRIBSO IN DENMARK AFTER 1950,
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
S. Wium-Andersen.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 76-84. 12 fig, 10 ref.

Descriptors: *Acid rain effects, *Lakes, *Water pollution effects, *Acidic water, *Denmark, Forest watersheds, Bogs, Humic acids, Acidity, Hydrogen ion concentration, Tributaries, Epilimnion, Secchi disks, Population dynamics, Species composition, Phytoplankton, Melosira, Waterfleas, Rotifers, Benthic fauna, Fish.

Lake Gribso is a polyhumic acid lake situated in North Zealand, Denmark. The catchment area is covered 77% with spruce, 22% with deciduous trees and 5% with bogs. No sewage enters the lake. The pH of the tributaries is today, as in 1950, in the range of 3.2 to 3.9. The mean acidity of the tributaries is 1 meq/L. The pH of the epilimnion of the lake dropped from 5.2 in 1950 to 4.3 in 1985. Secchi-disk depth decreased from summer values around 3 meters in 1950 to 1 meter in 1985. The acidification seems to have accelerated during the past 35 years. Both flora and fauna have changed during the last century. All species of Melosira disappeared between 1919 and 1926. Many other phytoplankton species have disappeared, and only a few new ones have occurred. Today the phytoplankton is dominated by a very few species usually occurring in monocultures, e.g., Synura petersenii and S. sphagnicola, Dictyosphaerium pulchella, and a species of Chlamydomonas. The number of Bosmina and Daphnia were reduced from 1920 to 1940 and they disappeared altogether before 1985 together with Eudiaptomus. The rotifer Conochilus and the water mite Piona sp. were very common in 1940 but were not found in 1985. The bottom-living animals Asellus, Pisidium, Herbopdella, and Limnophilus were recorded from the lake 30 years ago but not in 1985. There are still perch and pike in the lake, but fry have not been seen. (See also W89-06680) (Author's abstract) W89-06688

CHEMISTRY OF ATMOSPHERIC DEPOSITION AND LAKE ACIDIFICATION IN NORTHERN ITALY, WITH EMPHASIS ON THE ROLE OF AMMONIA,
Istituto Italiano di Idrobiologia, Pallanza (Italy).
For primary bibliographic entry see Field 5C.
W89-06689

BUFFERING MECHANISMS IN ACIDIFIED ALPINE LAKES,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
J. Zobrist, L. Sigg, J. L. Schnoor, and W. Stumm.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 95-103. 2 fig, 4 tab, 9 ref.

Descriptors: *Acid rain effects, *Buffering, *Lakes, *Acidic waters, *Alpine regions, *Neutralization, Watersheds, Crystalline rocks, Weathering, Air pollution effects, Ammonium, Hydrogen ion concentration, Alkalinity.

Under the climatological conditions prevailing in alpine regions, chemical weathering of rocks represents the principal reaction that neutralizes the acid inputs into the watersheds and that affects the water composition. The load of strong acids is due to wet and dry atmospheric deposition and is also due to the oxidation and assimilation of the ammonium that is inserted by atmospheric deposition. Four small and shallow lakes were studied during a snow-free period. They are situated in the central part of the Alps above 2000 m in an area with granitic gneiss and little soil. The lakes not influenced by neighboring calcareous rocks had a pH between 4.9 and 6.0; the alkalinity varied between -10 and +20 microequiv/L. The atmospheric input of strong acids amounted to about 15 meq/sq m/y, the same quantity is additionally produced by ammonium oxidation and assimilation. The weathering rate of the crystalline rocks is about 20 meq/sq m/y. (See also W89-06680) (Author's abstract) W89-06690

ACIDITY MITIGATION IN A SMALL UPLAND LAKE,
Cambridge Univ. (England). Dept. of Applied Biology.
For primary bibliographic entry see Field 5G.
W89-06691

PESTICIDE MICROPOLLUTANTS IN LAKE ALBUFERA (SPAIN),
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
For primary bibliographic entry see Field 5B.
W89-06755

HYDROLOGIC AND CLIMATOLOGIC FACTORS AFFECTING WATER LEVELS OF DEVILS LAKE, NORTH DAKOTA,
Geological Survey, Bismarck, ND. Water Resources Div.
G. J. Wiche.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4320, 1986. 62p, 12 fig, 9 tab, 79 ref.

Descriptors: *Limnology, *Water level, *Lakes, *Climatology, *Hydrologic studies, *Devils Lake, *North Dakota, Predicting, Lake evaporation, Seasonal variation, Runoff, Hydrology.

High water levels of Devils Lake, North Dakota, and other terminal lakes, have, in recent years, threatened highways, agricultural land, recreational cabins, and communities located near these lakes. This study was undertaken to describe the hydrology of the Devils Lake basin and to determine how to estimate future water level probabilities. Analysis of the available hydrologic and climatologic data indicates the water level of Devils Lake fluctuates largely in response to climatic variability. Average annual net storage gain has varied from 70,000 acre-feet for 1969-83 to as little as 4,530 acre-feet for 1931-40. In addition to the influence of climatic variability on the inflow to Devils Lake, an interconnected chain of lakes upstream of Devils Lake retains runoff and acts as an evaporation basin for runoff from the Devils Lake basin. During 1965-67, at least 112,000 acre-feet of water was stored in this upstream chain of lakes. A review of research conducted on other terminal lakes indicated that the water level in these lakes fluctuated primarily in response to climate variability. There is agreement between water level fluctuations of terminal lakes in Western North America and water level fluctuations of Devils lake during times of climatic extremes. No standardized methods are available for computing water level probabilities of terminal lakes. Most of the development of a method for determining future water level probabilities has been focused on Great Salt Lake, Utah. A number of techniques have been used to

estimate the future water-level probabilities for Great Salt Lake; however, they provide a wide range in probability of occurrence for any given water level. (Author's abstract)
W89-06830

INTERDISCIPLINARY APPROACH TO VALUATION OF MICHIGAN COASTAL WETLANDS,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6B.
W89-06879

BATHYMETRY OF LAKES MARION AND MOULTRIE, SOUTH CAROLINA,
Geological Survey, Columbia, SC. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06880

EFFECTS OF THE 1980 ERUPTION OF MOUNT ST. HELENS ON THE LIMNOLOGICAL CHARACTERISTICS OF SELECTED LAKES IN WESTERN WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
S. S. Embrey, and N. P. Dion.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4263, 1988. 60p, 14 fig, 6 tab.

Descriptors: *Volcanoes, *Limnology, *Mount St. Helens, *Washington, Lakes, Blast-zone lakes, Phytoplankton, Zooplankton, Turbidity, Silting, Dissolved oxygen.

The 1980 eruption of Mount St. Helens provided the opportunity to study its effect on the physical, chemical, and biological characteristics of lakes near the volcano, and to describe two newly created lakes. Concentrations of dissolved solids and organic carbon, measured in June 1980, had increased from 2 to 30 times those observed in the 1970's in Spirit, St. Helens, and Venus Lakes. Water in the lakes was altered from preeruption calcium-bicarbonate types to calcium-sulfate, calcium sulfate-chloride, or lake surface, as in St. Helens Lake; transparency in Venus Lake had improved to a depth of 24 ft by 1982. Spirit Lake was anoxic into fall 1980, but had reaerated to 5.2 mg/L of dissolved oxygen by May 1981. Phytoplankton communities in existing lakes in the blast zone in 1980 were primarily green and bluegreen algae; diatoms were sparse until summer 1982. Small numbers of zooplankton in Spirit, St. Helens, and Venus Lakes, compared to numbers in Walupt and Fawn Lakes, may indicate some post-eruption mortality. Rotifers were absent from lakes in the blast zone, but by 1981 were observed in all the lakes. The recovery of the physical, chemical, and biological characteristics of the lakes will depend on stabilization of the surrounding environment and biological processes within each lake. Excluding Spirit Lake, it is estimated that St. Helens Lake would be the slowest to recover and Venus Lake the fastest. (USGS)
W89-06881

TIME SERIES AND TRANSECT ANALYSIS OF WATER QUALITY IN SAYLORVILLE AND RED ROCK RESERVOIRS,
Iowa State Univ., Ames. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-06920

HYDROLOGY OF THE OKEFENOKEE SWAMP WATERSHED WITH EMPHASIS ON GROUNDWATER FLOW,
Georgia Univ., Athens. Graduate School.
For primary bibliographic entry see Field 2F.
W89-06925

BUOYANCY INDUCED PLUNGING FLOW INTO RESERVOIRS AND COASTAL REGIONS,
Minnesota Univ., Minneapolis. Graduate School.
For primary bibliographic entry see Field 2E.
W89-06947

FINITE ELEMENT MODELING OF SHALLOW WATER WAVES,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
A. P. Maestrini.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8711606. Ph.D. Dissertation, 1987. 138p, 59 fig, 3 tab, 65 ref, 3 append.

Descriptors: *Shallow water, *Model studies, *Computer models, *Finite element method, *Wave action, Wave velocity, Mathematical models, Numerical analysis, Tidal waves.

Shallow water waves were modeled using six-node triangular finite element model with quadratic interpolation for both velocities and depths and full centering in time. Convective terms, friction and Coriolis effects, and effective shear stresses were considered. The model uses the same explicit-implicit scheme to proceed in time and the same solution technique as in Hosseinipour's model. The general behavior of the model is compared with analytical solutions in the literature. Computed velocities and water depths are checked against Rahman's analytical solutions and results using three-node triangular elements are compared with those for six-node triangular elements. (Cremmins-AEPCO)
W89-06960

2I. Water In Plants

MODELLING NITRATE REMOVAL BY RIPARIAN VEGETATION IN A SPRINGFED STREAM: THE INFLUENCE OF LAND-USE PRACTICES,
Massey Univ., Palmerston North (New Zealand). Dept. of Mathematics and Statistics.
For primary bibliographic entry see Field 2E.
W89-05882

HYDROLOGICAL AND CHEMICAL INPUTS TO FIR TREES FROM RAIN AND CLOUDS DURING A 1-MONTH STUDY AT CLINGMANS PEAK, NC,
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 5B.
W89-05915

WET DEPOSITION ESTIMATES FROM LONG-TERM BULK AND EVENT WET-ONLY SAMPLES OF INCIDENT PRECIPITATION AND THROUGHFALL,
Duke Univ., Durham, NC. School of Forestry and Environmental Studies.
For primary bibliographic entry see Field 2B.
W89-05934

FLOW OF WATER THROUGH ROOT-SOIL ENVIRONMENT,
California Univ., Davis. Dept. of Land, Air and Water Resources.
For primary bibliographic entry see Field 2G.
W89-05958

HYDROLOGIC BALANCE MODEL USING NEUTRON PROBE DATA,
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W89-05961

FLOODPLAIN VEGETATION OF THE IBI RIVER IN CENTRAL JAPAN: I. DISTRIBUTION BEHAVIOR AND HABITAT CONDITIONS OF THE MAIN SPECIES OF THE RIVER BED VEGETATION DEVELOPING ON THE ALLUVIAL FAN, ENGLISH SUMMARY.
Kochi Univ. (Japan). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-05969

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 1. PHYSICAL AND CHEMICAL ENVIRONMENT,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-06149

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 2. CHEMISTRY OF SITES AT MANIKGANJ AND SONARGAON,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-06150

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 3. ASSOCIATED ALGAE AND MACROPHYTES,
Durham Univ. (England). Dept. of Botany.
B. A. Whitton, A. Aziz, B. Kawecka, and J. A. Rother.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 31-42, November 10, 1988. 4 fig, 4 tab, 17 ref. United Kingdom Overseas Development Administration Contract R3630A and R3983. Commission of the European Communities Contract TSD-A.207.

Descriptors: *Ecology, *Limnology, *Macrophytes, *Oxygen depletion, *Rice paddies, *Bangladesh, *Algae, Ecology, Cyanophyta, Flood plains, Diatoms, Magnesium, Calcium.

Aquatic macrophytes formed dense beds in fallow areas during the four and a half months of the flood season in all but one deepwater rice-growing location in Bangladesh; these included several types of life-form, but the fine-leaved species, Myriophyllum sp., Najas indica, and Utricularia stellaris were often especially abundant. The same species grew inside deepwater rice fields, but at much lower densities. A similar contrast occurred for the algae, although deepwater rice often developed dense masses of epiphytes on aquatic roots, stems and leaf sheaths, when plants were growing in isolated, well-illuminated situations. Two widespread algae, Aulosira fertilissima and Scytonema mirabile, were equally successful on soil in the period prior to the arrival of floodwaters and floating on the surface of the water during the flood season. Other species common during the flood season differed from those common on soil. Most blue-green algae inside deepwater rice fields were heterocystous; the only species not so, but forming distinct colonies, was Aphanothece stagnina. However only non-heterocystous forms were found at one location in south Bangladesh (Phaltita) and a change from heterocystous to non-heterocystous forms was noted at the main research site (near Sonargaon) during late September in at least one year. The water column at the former was almost entirely anoxic, while the change at the latter occurred at a time when the water sometimes became anoxic during the night. It is suggested that differences in ability to tolerate anoxic periods may be a key factor in determining the success of the algal and vascular plant species in the different micro-habitats within these DWR-growing areas. Although diatoms were quantitatively only a minor component of the algal biomass, they became more frequent later in the season when the water became microaerobic or anoxic for part of the day. Navicula confervacea was overall the most abundant species at the two main research locations. (See also W89-06149) (Author's abstract)
W89-06151

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 4. NITROGEN FIXATION BY BLUE-GREEN ALGAL COMMUNITIES,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-06152

ECOLOGY OF DEEPWATER RICE-FIELDS IN BANGLADESH: 5. MINERAL COMPOSITION OF THE RICE PLANT AND OTHER AQUATIC MACROPHYTES,
Durham Univ. (England). Dept. of Botany.
For primary bibliographic entry see Field 2H.
W89-06153

HYDROLOGY AND SOIL FERTILITY OF DEGRADED GRASSLANDS AT CHERRAPUNJI IN NORTHEASTERN INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
For primary bibliographic entry see Field 4C.
W89-06158

INTERRELATIONSHIPS BETWEEN THE GROWTH OF HYDRILLA VERTICILLATA (L.F.) ROYLE AND SEDIMENT NUTRIENT AVAILABILITY,
Waterways Experiment Station, Vicksburg, MS.
For primary bibliographic entry see Field 2H.
W89-06248

BIOMASS VARIANCE FUNCTION FOR AQUATIC MACROPHYTES IN ONTARIO (CANADA) SHIELD LAKES,
Toronto Univ. (Ontario). Inst. for Environmental Studies.
For primary bibliographic entry see Field 2H.
W89-06249

ECOLOGICAL STUDIES ON POTAMOGETON PECTINATUS L. II. AUTECOLOGICAL CHARACTERISTICS, WITH EMPHASIS ON SALT TOLERANCE, INTRASPECIFIC VARIATION AND ISOENZYME PATTERNS,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
For primary bibliographic entry see Field 2H.
W89-06250

SIGNIFICANCE OF SEDIMENTARY PHOSPHORUS TO A ROOTED SUBMERSED MACROPHYTE (NAJAS FLEXILIS (WILLD.) ROSTK. AND SCHMIDT) AND ITS ALGAL EPIPHYTES,
Michigan State Univ., Hickory Corners. W.K. Kellogg Biological Station.
For primary bibliographic entry see Field 2H.
W89-06251

EFFECT OF FLOODING ON WILD RICE, ZIZANIA AQUATICA L.,
Winnipeg Univ. (Manitoba). Dept. of Biology.
For primary bibliographic entry see Field 2H.
W89-06252

DISTRIBUTION OF ZOSTERA MARINA L. AND RUPPIA MARITIMA L. SENSU LATO ALONG DEPTH GRADIENTS IN THE LOWER CHESAPEAKE BAY, U.S.A.,
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2L.
W89-06253

FACTORS INFLUENCING PHOTOSYNTHETIC PRODUCTIVITY OF CHARA VULGARIS L. IN A MODERATELY PRODUCTIVE HARD-WATER LAKE,
Wayne State Univ., Detroit, MI. Dept. of Biological Sciences.
R. A. Hough, and D. A. Putt.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 411-418, December 1988. 2 fig, 6 tab, 26 ref. NSF Grants DEB 7604503 and DEB 81-D3528.

Descriptors: *Limnology, *Photosynthesis, *Aquatic productivity, *Chara, *Productivity, *Chlorophyta, Lakes, Seasonal variation, Alga, Limiting nutrients, Michigan.

In situ seasonal patterns and ecophysiology of photosynthesis were investigated in the macroalga Chara vulgaris L. growing in Shoe Lake, Michigan, in an effort to understand controlling factors and to determine the role of photorespiration. G. vulgaris was shown to be a C3 plant with inducible photorespiration. Its photosynthetic productivity in Shoe Lake in early summer was maximal for submersed macrophytes. Subsequent seasonal declines and daily fluctuations in productivity were correlated with presence of photorespiration, but the photorespiration represented a minor percentage of photosynthesis. In the shallow light-saturated water both nitrogen and carbon availability were limiting factors at times during midsummer and late summer. (Author's abstract)
W89-06317

RECOLONIZATION OF SMALL DISTURBANCE PATCHES IN A NEW ENGLAND SALT MARSH,
Harvard Univ., Cambridge, MA. Dept. of Landscape Architecture.
For primary bibliographic entry see Field 2L.
W89-06374

PREDICTABILITY OF CHANGE IN SHORELINE VEGETATION IN A HYDROELECTRIC RESERVOIR, NORTHERN SWEDEN,
Umea Univ. (Sweden). Dept. of Ecological Botany.
C. Nilsson, and P. A. Keddy.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1896-1904, November 1988. 5 fig, 5 tab, 51 ref.

Descriptors: *Shoreline cover, *Vegetation, *Statistical analysis, *Reservoirs, *Hydroelectric power, Sweden, Species composition, Prediction, Bryophytes, Lichens.

The feasibility of predicting responses of vegetation to specified perturbations acting on a known initial state using 10 yr of vegetation data and precise water level records from the Gardiken Reservoir on the Ume River in Sweden was studied; this has a restricted flora and one obvious controlling factor: water level. Abundance and species richness were strongly correlated for both vascular and nonvascular plants (bryophytes and lichens). Duration of flooding was the most important variable controlling those independent variables chosen for study. The change from year t to t+1 could be roughly predicted for community attributes such as richness and cover (Regression coefficient > 0.33) but not for species composition (Regression coefficient < 0.04). The initial (preceding-year) state of the system and the duration of flooding (also in the preceding year) were always the two most important independent variables. Even in this simple system with presumably one major control variable, the best regression equation accounted for only 41 of the variation. Community properties were more predictable than species composition. The similarity of the species pool, the lack of coupling from competitive interactions, and the high degree of immaturity may have reduced predictability of species composition. (Author's abstract)
W89-06375

LEAF WATER POTENTIAL AND LEAF CONDUCTANCE DURING THE GROWING SEASON IN ALMOND TREES UNDER DIFFERENT IRRIGATION REGIMES,
Centro de Edafologia y Biologia Aplicada del Segura, Murcia (Spain).
For primary bibliographic entry see Field 3F.
W89-06385

CALIBRATION OF A ROOT WATER UPTAKE MODEL IN SPATIALLY VARIABLE SOILS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
J. W. Hopmans, and E. Guttierez-Rave.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 53-65, November 15, 1988. 3 fig, 5 tab, 14 ref.

Descriptors: *Calibrations, *Roots, *Soil-water-plant relationships, *Model studies, *Unsaturated flow, Soil types, Flow, Soil water, Hydraulic properties, Monte Carlo method, Optimization, Transpiration.

The application of a procedure to calibrate a root water uptake model in unsaturated water flow modeling is discussed, taking into consideration the variability of soil hydraulic properties. In previous studies, the reduction function was calibrated at only one site, and it was assumed that the resulting sink term is representative for the whole study area. However, in general, large areas show an increasing soil variability and may require a different approach. A Monte Carlo analysis in combination with a trial-and-error procedure to optimize the parameters of the reduction function resulted in improved values for the actual transpiration when compared with the single site calibration. However, there was still a considerable deviation from measured transpiration if the proposed analysis was applied to the extremely dry growing season of 1976. (Doria-PTT)
W89-06511

WATER USE AND IRRIGATION RESPONSE TO DEFOLIATED CORN WITH VARIOUS POPULATIONS,
Nebraska Univ.-Lincoln.
For primary bibliographic entry see Field 3F.
W89-06952

2J. Erosion and Sedimentation

ROLE OF BOTTOM MORPHOLOGY ON ESTIMATION OF THE TRANSPORT OF SOLIDS IN RIVERS (LE ROLE DE LA CONFORMATION DU FOND DANS L'ESTIMATION DU TRANSPORT SOLIDE EN RIVIERE),
Ecole Hassania des Travaux Publics, Casablanca (Morocco).
A. Sadok, and C. Marche.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 509-515, August 1988. 7 fig, 42 ref. English summary.

Descriptors: *Channel morphology, *Rivers, *Hydraulic roughness, *Bed load, *Saltation, *Sediment transport, *River beds, Particulate matter, Sedimentation, Suspended load, Statistical analysis, Fluvial sediments, Surface flow, Mathematical models.

Bed configuration is shown to be a relevant parameter of the saltation movement of solid particles in free surface flow. Analytical and statistical results confirm the importance of this parameter on bed-load and suspended-load. A review of global effects of bed configuration on sedimentation is discussed. Some of the relevant literature on this topic is presented along with a comparison of some current models of bed configuration and solids transport. The incidence of river bed configuration modeling to explain saltation movement is examined. Parameters that characterize solids transport in relation to bed load configuration are analyzed. (Geiger-PTT)
W89-05823

MOBILE BOUNDARY FLOW: AN ASSESSMENT OF VELOCITY AND SEDIMENT DISCHARGE RELATIONSHIPS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
A. W. Peterson, and A. E. Peterson.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 539-546, August 1988. 4 fig, 3 tab, 18 ref.

Descriptors: *Boundary processes, *Flow velocity, *Sediment transport, *Sediment discharge, Mathematical models, Regression analysis, Water depth, Prediction, Flow profiles, Particle size.

Using the data from Brownlie's update of the Compendium of Solids Transport Data, velocity and sediment discharge equations have been derived using regression analysis. Two velocity equations have been determined, one for the lower flow regime and the other for the upper flow regime. A single equation for sediment discharge covers both

flow regimes. The equations provide estimation/prediction of sediment discharge and velocity that are simple to use. Plots of over 3000 test results show the relationship of sediment discharge, velocity, flow depth, energy gradient, and sediment size for the lower and upper flow regimes. Included in the plots are estimation and prediction limits for the velocity and sediment discharge relationships. (Author's abstract)
W89-05824

STREAMWATER CHEMISTRY DURING RAINFALL EVENTS IN A FORESTED BASIN,
National Inst. for Environmental Studies, Yatabe (Japan). Div. of Water and Soil Environment.
K. Muraoka, and T. Hirata.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 235-253, September 30, 1988. 9 fig, 2 tab, 18 ref.

Descriptors: *Forest hydrology, *Nutrients, *Water chemistry, *Soil water, *Experimental basins, *Geochemistry, *Solute transport, *Weathering, *Rainfall, Trace elements, Essential nutrients, Silica, Chlorides, Sodium, Nitrates, Potassium, Ions, Calcium, Magnesium, Hydrographs, Chemical denudation, Hydrology, Forest watersheds.

The hydrochemistry of streams was measured during two water cycles in an experimental forested basin of 67.5 ha. The chemical changes of streamwater measured during four rainfall runoff events make it possible to distinguish two types of solute element behavior. Until the peak flow, the concentration of each element decreases due to a dilution effect by the surface runoff water. During the recession period, the concentrations increased in two major modes: Type I, which shows approximately the same concentrations around the end of the runoff period as the baseflow level prior to the runoff event and Type II, which overshoots the baseflow level. Type I includes SiO2, specific conductance, Cl(-), and Na(+), whereas Type II includes NO3(-)-N, K(+), Ca(2+), and Mg(2+). During the recession period, the streamwater might be originating mainly from interflow, probably associated with surface soil water, therefore the soil water chemistry was analyzed. SiO2, originating from soil and bedrock, showed nearly uniform concentration in the downward direction and NO3(-)-N concentration near the soil surface was greater than that of the deep soilwater and streamwater. The two results correspond to the runoff characteristics of Types I and II, respectively. The materials classified into Type II are the major essential elements in the metabolism of the forest ecosystem, whereas those of Type I are minor or nonessential elements. (Author's abstract)
W89-05852

BLUFF RESPONSE TO WAVE ACTION,
Pittsburgh Univ., PA. Dept. of Civil Engineering.
L. E. Vallejo, and R. Degroot.
Engineering Geology EGGOAO, Vol. 26, No. 1, p 1-16, August 1988. 10 fig, 1 tab, 25 ref.

Descriptors: *Lakes, *Bluffs, *Erosion, *Wave action, *Great Lakes, Coasts, Lake shores, Beach erosion, Beach profiles, Aerial photography.

The unconsolidated materials forming the bluffs along the coasts of the Great Lakes are subject to active wave erosion which results in losses in millions of dollars annually due to property damage and reduction in property values. An understanding of the mechanics of bluff recession and the long-term trends in the evolution of coastal bluffs is required for an evaluation of engineering and management solutions for the problems created by retreating coastal bluffs. Bluff retreat is usually analyzed and measured from airphotos. However, since airphotos are taken at discrete points in time they are not capable of providing a full account of bluff retreat mechanisms. Field investigations, coupled with analytical methods, can enable investigators to identify patterns of bluff retreat. These patterns, subsequently incorporated into slope evolution models, shed light on data obtained over long periods from airphotos. This paper explains recession rates and bluff profile changes as measured from airphotos with the help of bluff evolution models already established for the bluffs forming the Great Lakes shorelines. (Author's abstract)
W89-05919

EFFECTS OF OXYGEN ON HYDROCARBON DEGRADATION STUDIES IN VITRO IN SURFICIAL SEDIMENTS,
Aix-Marseille-2 Univ. (France).
For primary bibliographic entry see Field 5B.
W89-05992

RIVER MANAGEMENT TO REDUCE TURBIDITY IN NAVIGABLE BROADLAND RIVERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W89-06005

NATURAL TRACERS TO DETERMINE THE ORIGIN OF SEDIMENTS AND SUSPENDED MATTER FROM THE ELBE ESTUARY,
Institute for Soil Fertility, Haren (Netherlands).
W. Salomons, E. Schwedhelm, J. Schoer, and H. Knauth.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 89-102, 1988. 11 fig, 27 ref.

Descriptors: *Suspended load, *Tracers, *Environmental tracers, Isotopic tracers, *Sediments, *Sediment transport, *Estuaries, Sediment distribution, The Netherlands, Chemical composition, Carbonates, Clay minerals, Particle size, Saline-freshwater interfaces, North Sea, Organic matter, Marine sediments.

The clay mineral composition, the concentrations of carbonates, the proportions of carbon and oxygen isotopes in carbonates and organic matter as well as the concentrations of different elements have been used to determine the origin of several grain size fractions of the sediment and the suspended matter from the Elbe estuary. The clay mineral composition, especially the smectite-kaolinite proportion, demonstrated that solid material $< = 2$ microns from the North Sea is transported up the river, about 50 km beyond the average position of the salt wedge. As far as the fraction 2-20 microns is concerned, the upward transport of North Sea material was proved; by the calcite concentration, the Ca:Sr proportion n total particulates and the isotopic composition of the carbonates, demonstrating a transport of at least 40 km beyond the marine water limit. The transport behavior of the grain size fraction 20-63 microns could be determined by the Hf concentration. In this case, the distance of transport beyond the salt wedge was around 30 km. The isotopic composition of the carbonates confirmed the landward transport of this fraction. The organic matter in the coarser fractions was partly derived from debris of marsh vegetation. Due to the contribution of sources within the estuary, information obtained from this tracer pertained to the origin of the organic matter only. The results demonstrate the mixing between marine and fluvial sediments and transport of marine sediments past the salt wedge. This physical process occurs with chemical processes responsible for the observed decrease of pollutants concentrations in solid matter along the estuary. Additionally, the different amounts of the upstream transport distances of the investigated grain size fractions support the hypothesis of settling and scour lag induced particulate transport. (Author's abstract)
W89-06024

DEVELOPMENT OF A NEW SIMULATION METHOD FOR SUSPENDED SEDIMENT TRANSPORT IN A TIDAL RIVER,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
T. Futawatari, T. Kusuda, K. Koga, H. Araki, and T. Umita.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 103-112, 1988. 16 fig, 1 tab, 3 ref.

Descriptors: *Model studies, *Simulation, *Suspended sediments, *Tidal rivers, *Sediment transport, Model testing, Hydrologic models, Erosion, Deposition, Erosion rates, Tributaries.

A one dimensional simulation model of suspended sediment transport in a tidal river was developed with erosion, deposition, and thickening processes of sediments, and inflow from tributaries. This model uses the explicit leap-frog method and its lower end boundary of the river is extended into the sea to close the boundary for calculation. Laboratory experiments were performed to determine erosional and depositional rates of sediments and to study the sediment thickening process in the river under various concentrations of chlorinity and suspended solids. Numerical simulation results, with the parameter values obtained experimentally, did not show good agreement with observed data. Modifying the parameter values according to physical phenomena was necessary to obtain good agreement in between. After the modification, computation results during a fortnightly cycle explain satisfactorily the sediment transport phenomena in this river. (Author's abstract)
W89-06025

STUDY ON THE SEASONAL VARIATION OF SURFACE SEDIMENT COMPOSITION IN ESTUARIES,
Okayama Univ. (Japan). Dept. of Civil Engineering.
O. Kawara.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 123-132, 1988. 23 fig, 2 tab, 12 ref.

Descriptors: *Path of pollutants, *Sediment transport, *Sediments, *Estuaries, *Sediment sorting, *Seasonal variation, Japan, Particle size, Sediment concentration, Flow discharge, Runoff.

The purpose of this study, as the first step toward clarifying the pollutant transport mechanism of sediments, is to clarify the characteristics of the seasonal changes of surface sediment composition in estuaries based on observation. Remarkable seasonal variations are found in the particle size distributions and the concentrations of the constituents of the surface sediments, though the patterns of the variations are different in each estuary observed. The seasonal variations of the concentrations show good correspondence to those of the particle size distributions. One cause of the seasonal variation is the variation of river discharges. When the sediment size in the Asahi River estuary, Okayama prefecture, became finer, the fresh water inflow to the estuary was about 2.5-3.5 times as much as ordinary water runoff (100-150 cu m/s) and the change was completed in about 10 days. On the other hand, the change to coarser sediment was completed in a day, by the inflow of over 400 cu m/s. (Author's abstract)
W89-06027

LONGITUDINAL AND VERTICAL CHANGES IN LAKE ESTUARINE SEDIMENTS,
National Inst. for Environmental Studies, Tsukuba (Japan).
K. Amano, and T. Fukushima.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 143-153, 1988. 4 fig, 4 tab, 11 ref.

Descriptors: *Sediment distribution, *Water pollution sources, *Lake sediments, *Sedimentology, Japan, Heavy metals, Nutrients, Linear alkyl sulfonates, Environmental gradient.

In order to obtain environmental information about lake water and watersheds, the distributions of physical and chemical properties in lake sediments were investigated. The concentrations of several substances (e.g., nutrients, metals, and chemicals) in the sediments were determined at fifty sampling sites in sixteen shallow lakes in Japan. The vertical profiles of particle size, particle organic carbon, particle organic nitrogen, total phosphorus, some metals (Ti, Mn, Fe, Zn, and Cu), and LAS were analyzed. Various sediment properties, such as the sedimentation conditions and the redox conditions, were related to the vertical profiles observed, and traces of historical changes in the water and watersheds were found in the sediments. Longitudinal

changes in the sediments between the mouths of the rivers and the deepest points of the lakes were clearly observed, and it was expected that these changes would correlate with one of the estuarine characteristics since they reflect the spatial variation in average composition of the particulate matter and in the average water quality. Some significant relationships between the lake sediments and the lake or watershed type were observed, indicating the possibility that lake sediments may be one of the most important indices for understanding lake environments. (Author's abstract)
W89-06029

RESUSPENSION OF SEDIMENTS FROM LONG ISLAND SOUND (U.S.A.),
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
C.-H. Tsai, and W. Lick.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 155-164, 1988. 8 fig, 1 tab, 7 ref.

Descriptors: *Suspended sediments, *Marine sediments, *Long Island Sound, *Path of pollutants, *Sediment transport, Shear stress, Particle size, Clams, Suspension, Flumes.

Resuspension experiments were conducted in sea water in an annular flume on fine-grained sediments from Long Island Sound. From these experiments, the resuspension rates and the sediment concentrations at steady-state were quantitatively determined as a function of shear stress and bed compaction. In addition, net resuspension experiments were conducted. From these, the total amount of sediment that could be resuspended at a particular shear stress was determined. In these tests, the resuspension rate decreased with time and the total amount of sediment that could be resuspended at a constant shear stress approached a constant value as time increased. This demonstrates a major difference between the resuspension characteristics of fine-grained sediments and those of uniform-size, coarse-grained, non-cohesive sediments. For the latter case, the resuspension rate ideally would be constant with time. Resuspension experiments were also conducted with deposit-feeding Nucula clams seeded into the sediment bed. In all cases, the steady-state concentrations as a function of shear stress were significantly greater than those in tests without Nucula. The tests also suggest that after sediments are seeded with Nucula for approximately 7 days, the sediment resuspension does not change with time of consolidation. (Author's abstract)
W89-06030

ROLE OF FINE SEDIMENT BEHAVIOUR IN POLLUTANT TRANSFER MODELLING,
Blackdown Consultants Ltd., Taunton (England).
W. R. Parker.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 175-182, 1988. 3 fig, 31 ref.

Descriptors: *Solute transport, *Sediment transport, *Model studies, *Sediment-water interfaces, *Path of pollutants, *Particle size, Kinetics, Cohesive soils, Sorption, Particle size, Model testing.

The role played by fine cohesive sediment in the transport and recycling of pollutants arises from the often reversible partition of pollutants between the dissolved phase and surface sorbed phase. Adequate prediction requires that a realistic understanding of the physical behavior of the fine sediment population of an area is coupled with the kinetics of the sorption/desorption equilibria at crucial stages in the fine sediment transport cycle. This paper examines the physical basis underlying the prediction of fine sediment transport, identifying processes and phenomena which are important in affecting predictions. Parameterization of source and sink terms are seen to be areas of great uncertainty and model calibration requires the deployment of new, but available, technology. (Author's abstract)
W89-06032

SOME STUDIES TO REDUCE SEDIMENTATION IN A PORT ON A TIDAL RIVER,
Hanover Univ. (Germany, F.R.). Franzius-Inst. fuer Wasserbau und Kuesteningenieurwesen.
K.-D. Muller, and H. Schwarze.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 253-261, 1988. 10 fig, 7 ref.

Descriptors: *Silting, *Tidal effects, *Port facilities, *Tidal rivers, Sediment control, Harbors, Dredging, Heavy metals, Model studies, Channel improvements.

Sedimentary material containing harmful substances dredged from seaports has become an increasing problem over the past few years. A main part of the sediment, mostly silt, contaminated with heavy metals, settles out in the region of harbor entrances. For the huge harbor basin of the Port of Hamburg investigations in a physical model had been carried out to find measures for reducing the sediment intrusion into the harbor basin. The investigations show that, because of the relationship of the harbor entrance to the large harbor surface, the tidal effect has a great influence on the current effect. As a result, construction measures, which in other cases considerably reduce sedimentation by eddies in the harbor entrance, have proved to be of little effect here. Under these circumstances the current effect could only be reduced by massive means, such as the installation of a current-deflecting wall. (Author's abstract)
W89-06041

FIELD OBSERVATION AND SIMULATION OF SEDIMENT RESUSPENSION IN A SHALLOW LAKE,
National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div.
K. Otsubo, and K. Muraoka.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 263-270, 1988. 6 fig, 1 tab, 9 ref.

Descriptors: *Suspension, *Shallow water, *Lakes, *Bottom sediments, *Suspended sediments, *Simulation, Field tests, Model studies, Turbidity, Numerical analysis, Wind, Erosion.

The dispersion and resuspension of sediments in the Takahamairi Bay basin of Lake Kasumigaura were studied by means of field research and numerical simulation. The field data on wind direction and velocity, lake current, water wave, and turbidity are shown. Based on these results, resuspension of precipitated sediments in this shallow lake is discussed. To predict the turbidity and the depth of bed erosion, a simulation model was established for this lake. The calculated turbidity showed good agreement with the field data. According to the simulated results, the turbidity reaches 200 ppm, and the bed is eroded several millimeters deep when the wind velocity exceeds 12 m/s in the lake. (Author's abstract)
W89-06042

FUNDAMENTAL INVESTIGATION OF GRAVITY CURRENTS WITH VARYING DENSITY,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 2H.
W89-06060

SEQUENTIAL EXTRACTION OF IRON, MANGANESE, ALUMINUM, AND SILICON IN SOILS FROM TWO CONTRASTING WATERSHEDS,
Science Applications International Corp., Oak Ridge, TN.
For primary bibliographic entry see Field 2G.
W89-06087

DISTINCTIVE ATTRIBUTES OF DEBRIS TORRENTS,
British Columbia Univ., Vancouver. Dept. of Geography.
O. Slaymaker.
Hydrological Sciences Journal HSJODN, Vol. 33, No. 6, p 567-573, December 1988. 1 fig, 41 ref. French summary.

Descriptors: *Detritus flows, *Landslides, *Debris flows, *Mudflows, *Rapid flow, *Channel flow, *Organic matter, *Sediment transport, *Debris torrents, Reviews, Flow, Sediments, Fluvial sediments, Pacific Northwest, Saturated soils, Gravity flow, Rheology, Runoff, Avalanches, Snowmelt, Rockslides, Mass wasting.

The term debris torrent was introduced in North America's Pacific Northwest region to describe coarse-grained, rapid channelized flows rich in organic debris. Environmental conditions favoring their occurrence and distinctive criteria for recognizing debris torrents are discussed. Correct identification of sites subject to debris torrents is a major problem. Four environmental criteria for the occurrence of debris torrents are: small drainage area, steep channels, high runoff intensity, and substantial debris available for mobilization. Both internal and external triggering mechanisms are important. Of the external mechanisms, storm and/or snowmelt runoff, water release from subglacial or lake storage, log jam bursts, rockfall, debris or snow avalanches from upslope or seismic shaking may all be important. Of the internal mechanisms leading to spontaneous bed instability, progressive steepening of the debris front between successive surges seems the most important in coarse debris torrents. No single rheological model is yet adequate to deal with debris torrents. A successful model should take account of at least the following: fines content, organic debris content, water content, and rate of shearing. (Doria-PTT)
W89-06088

HYDROLOGICAL CONTROLS OF EROSION AND SEDIMENT TRANSPORT IN VOLCANIC TORRENTS,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
K. Okunishi, H. Suwa, and S. Hamana.
Hydrological Sciences Journal HSJODN, Vol. 33, No. 6, p 575-587, December 1988. 9 fig, 1 tab, 12 ref.

Descriptors: *Debris torrents, *Mudflows, *Debris flows, *Rainfall-runoff relationships, *Erosion, *Sediment transport, *Volcanic torrents, Hydrology, Volcanoes, Japan, Gullies, Ravines, Gully erosion, Runoff, Surface runoff, Rainfall, Storms, Precipitation, Rainstorms, Topography, Entrainment.

Sediment is transported in the form of debris flows in major gullies dissecting permeable volcanic slopes as exemplified by the Kami-kamihori Valley in the northern Japan Alps. Four years of hydrological observations in the headwater area of the gully showed that the surface runoff which triggers debris flows is related to peak 10-minute to 20-minute rainfall. Sediment production in such a short time is not sufficient to prepare a debris flow. Therefore, debris must have been accumulated at a particular section by repeated sediment discharge due to minor rainstorms. The volume of the debris produced in the headwaters was evaluated and correlated to an effective rainfall. The quantity of sediment transport at seven sections along the gully by debris flows in three periods was evaluated through the measurement of topographic changes. It was compared with the total effective rainfall for the pertinent period, and the mean 'sediment concentration' in the debris flow was calculated for each section and for each period. It was shown that the change in the sediment concentration along the gully reflects the entrainment of debris from the gully floor in the acceleration zone and the deposition in the deceleration zone. It was also demonstrated that the sediment delivery of a debris flow depends on the time distribution of rainfall, because rainfall time bases appropriate to prediction of the sediment transport at different reaches vary. (Author's abstract)
W89-06089

MODEL FOR DEBRIS ACCUMULATION AND MOBILIZATION IN STEEP MOUNTAIN STREAMS,
British Columbia Univ., Vancouver. Dept. of Geography.
M. J. Bovis, and B. R. Dagg.

Hydrological Sciences Journal HSJODN, Vol. 33, No. 6, p 589-604, December 1988. 8 fig, 17 ref.

Descriptors: *Debris flows, *Mud flows, *Debris torrents, *Detritus, *Sediment transport, *Model studies, Accumulation, Mountains, Stream gradient, Hydraulic conductivity, Flow, British Columbia, Rainfall, Hydrology, Storms, Streams, Canada.

Previous work on the initiation of debris flows has emphasized the roles played by material strength, stream gradient, and fluid pressure, but in most published models the friction angle of the channel material is assigned some characteristic or constant value. A model is presented that retains gradient and pressure as variables, and considers the probable changes in friction angle and hydraulic conductivity, K, of channel debris over time. Preliminary results from the Howe Sound area in southwest British Columbia suggest that stream reworking may lead to small increases in friction angle and large increases in K, rendering channel debris more stable with time. This is partially offset by a local increase in channel gradient as debris accumulates. These factors favor the growth of large, marginally stable debris deposits, and may lead to high-magnitude, low-frequency debris torrents in channels not steep enough to produce torrents directly from hillslope failure events. An important part of this ongoing study is to monitor peak water levels associated with winter storms using rapid response pressure transducers. This program, combined with the measurement of spatial variability of high intensity rainfall, may clarify some of the important hydrological aspects of debris torrent initiation in the Howe Sound area. (Author's abstract)
W89-06090

EXPERIMENTAL STATION FOR THE AUTOMATIC RECORDING OF WATER AND SEDIMENT DISCHARGE IN A SMALL ALPINE WATERSHED,
Padua Univ. (Italy). Dept. of Land and Agro-Forest Environment.
For primary bibliographic entry see Field 7B.
W89-06091

CYCLE OF EARTHQUAKE-INDUCED AGGRADATION AND RELATED TIDAL CHANNEL SHIFTING, UPPER TURNAGAIN ARM, ALASKA, USA,
Geological Survey, Anchorage, AK.
S. Bartsch-Winkler.
Sedimentology SEDIAT, Vol. 35, No. 4, p 621-628, August 1988. 6 fig, 16 ref.

Descriptors: *Earthquakes, *Sedimentation, *Aggradation, *Estuaries, *Alaska, *Tidal currents, Channel accretion, Channel morphology, Subsidence, Intertidal areas, Channel erosion, revegetation.

Aggradation of intertidal sediment in upper Turnagain Arm, a macrotidal estuary located in southern Alaska near Anchorage, began because of subsidence caused by sediment consolidation and tectonic lowering of the land during the earthquake of March 27, 1964. At the head of the Arm, decrease in percent sand of surface sediments with time and return of rodents, pulmonate gastropods, trees, bushes, and grasses to the intertidal region, indicate that the rate of sediment deposition has slowed and the Upper Turnagain Arm area has returned to a state of pre-earthquake equilibrium only 17 years after the event. Comparison of channel locations before and after the earthquake indicates the possibility of regional postseismic tilting of the estuary. Postseismic tilting might have played a role in the eastward and northeastward shift in channel locations that occurred during 1966-1984 in upper Turnagain Arm. (Author's abstract)
W89-06198

CALCULATION OF THE DEPTH OF SCOUR IN ROCK DOWNSTREAM OF A SPILLWAY,
For primary bibliographic entry see Field 8B.
W89-06211

COPRECIPITATION OF PHOSPHATE WITH CALCITE IN LAKE WATER: A LABORATORY EXPERIMENT MODELLING PHOSPHORUS REMOVAL WITH CALCITE IN LAKE CONSTANCE,
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2K.
W89-06222

BEACH SEDIMENTS OF THE NORTHERN CARMEL COAST,
National Inst. of Oceanography, Haifa (Israel).
B. Gur, and V. Goldsmith.
Israeli Journal of Earth Science , Vol. 37, No. 1, p 23-36, 1988. 10 fig, 13 ref.

Descriptors: *Sedimentology, *Beach profiles, *Sediment transport, *Israel, Sediment erosion, Sand bars, Carmel Coast, Atlit, Haifa, Beach erosion, Erosion.

A sedimentological beach analysis was conducted of 54 berm, swash, and nearshore bar samples obtained in the coastal compartment of Israel between Atlit and Haifa, in conjunction with other geomorphological aspects. Approximately 40% of the sediment is composed of quartz, with the other components being carbonate rock fragments and biogenic fragments. The sediments are medium size sand, with mean grain size of the total sediment sample equal to 1-2 phi. The swash samples are either coarser than, or the same size as, the berm and bar samples. There is a slight overall trend of decreasing grain size to the north, with the best trend in the swash samples. Close inspection of the data reveals that this coastal compartment may be further subdivided into four subcompartments (on the basis of mean grain size). Sedimentological analyses of this coastal compartment show that selective sorting cannot alone explain the mean grain size and relative amounts of the three components comprising this sediment. Two additional processes are suggested: (a) local wave refraction causing diverging longshore transport nodal points; and (b) additional local sources of carbonate rock fragments, probably relict, which were either previously transported from the adjacent Carmel Mountain prior to man's influence on the rivers there or from the nearshore. There is a close correlation between the location of the three maxima of percent carbonate rock fragments and the mouths of the three rivers: Oren, Megadim/Mitla, and Galim. (White-Reimer-PTT)
W89-06247

MODEL FOR CALCULATING BED LOAD TRANSPORT OF SEDIMENT,
Washington Univ., Seattle. Dept. of Geological Sciences.
P. L. Wiberg, and J. D. Smith.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 101-123, January 1989. 1 tab, 8 fig, 19 ref, append. NSF Grant OCE-8310712.

Descriptors: *Sediment transport, *Sediment load, *Bed load, *Saltation, *Model studies, Mathematical models, Particle size, Shear stress, Density, Shields' number, Yalin equation.

A bed load transport model based on the mechanics of sediment moving by saltation yields predicted values of bed load flux as a function of boundary shear stress, grain diameter and density. The parameters required to calculate bed load transport (particle velocity, bed load sediment concentration, and the height of the bed load layer) can all be determined from the model, which computes sequences of trajectories of individual saltating grains as well as the concentration of moving grains that the flow can support. Predicted curves of bed load transport vs. boundary shear stress agreed well with transport data collected by previously measured shear stress was corrected for pressure drag when bed forms were present. Comparison of predicted bed load transport with common bed load equations reveals considerable similarity among the relationships. The best agreement with the data is produced by relationships in which the transport rate vanishes as the shear stress approaches the critical Shields' number. (Author's abstract)
W89-06280

EFFECT OF SEDIMENT DENSITY ON BED-LOAD TRANSPORT,
Ministry of Works and Development, Christchurch (New Zealand). Hydrology Centre.
H. S. Low.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 124-138, January 1989. 3 tab, 12 fig, 11 ref, 2 append.

Descriptors: *Sediment transport, *Sediment load, *Sediment-carrying capacity, *Bed load, Saltation, Structural models, Particle size, Shear stress, Density, Einstein-Brown formula, Smart's formula.

The results of experiments on transport by water of synthetic lightweight sediments of specific gravities, where s is greater than 1.0 and less than 2.5, and uniform grain size, D = 3.5 mm, confirm the dimensional reasoning that the volumetric specific sediment transport rate, q sub s, is proportional to a simple power relation of the quotient, shear velocity/grain fall velocity (V*/w). The sediment transport rate, q sub s, is found to be proportional to the sixth power of the shear velocity, V*, and inversely proportional to the fifth power of the grain fall velocity, w. An empirical formula based on the dimensional reasoning and the results above is equivalent to the Einstein-Brown bed load formula. A comparison of the experimental data with the predictions of several common bed load formulas shows the behavior of these formulas with lightweight sediments. The Einstein-Brown formula and a modified version of Smart's formula provide good predictions. (Author's abstract)
W89-06281

SEPARATION AND SIZE CHARACTERIZATION OF COLLOIDAL PARTICLES IN RIVER WATER BY SEDIMENTATION FIELD-FLOW FRACTIONATION,
Chisholm Inst. of Tech., Melbourne (Australia). Water Studies Centre.
R. Beckett, G. Nicholson, B. T. Hart, M. Hansen, and J. C. Giddings.
Water Research WATRAG, Vol. 22, No. 12, p 1535-1545, December 1988. 8 fig, 1 tab, 36 ref. Dept. of Energy Contract DE-AC02-79EV10244.

Descriptors: *Sedimentation, *Particle size, *Suspended sediments, *Separation techniques, *Colloids, *Rivers, Australia, Graphical analysis, Fractionation, Suspended solids.

Methodologies for using sedimentation field-flow fractionation (FFF) to produce fractograms of suspended river colloidal matter have been developed. These fractograms are plots representing the content of particulate material at different elution volumes following the separation. The volume scale can be converted to effective particle mass using equations derived from first principles and to the more usual particle diameter scale if a particle density is assumed. Sample preconcentration is generally necessary and various techniques have been tested. The usefulness of exponential field programming for samples containing a large particle size range has been demonstrated. The effect of programming conditions on resolution, speed, and accuracy are discussed. Fractograms obtained for Yarra River (Australia) colloidal matter are found to contain a broad peak in the range 0.1-0.5 micrometer diameter. It is shown that the sedimentation FFF technique has considerable potential for the size characterization and fractionation of environmental samples. (Author's abstract)
W89-06301

INPUT OF RIVER-DERIVED SEDIMENT TO THE NEW ZEALAND CONTINENTAL SHELF: II. MINERALOGY AND COMPOSITION,
New Zealand Soil Bureau, Lower Hutt.
G. J. Churchman, J. L. Hunt, G. P. Glasby, R. M. Renner, and G. A. Griffiths.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 27, No. 4, p 397-411, October 1988. 1 fig, 6 tab, 62 ref.

Descriptors: *Fluvial sediments, *New Zealand, *Continental shelf, *Mineralogy, *Sedimentology, *Sediment discharge, *Clay minerals, Marine sediments, Chemical composition, Statistical analysis, Kaolin, Smectite, Mathematical studies.

Clay mineralogies and elemental compositions of river-borne sediments from New Zealand were examined as indicators of likely sources of the lithogenous component of sediments on the continental shelf. Relative occurrences of kaolin and smectite enabled the rivers to be fitted into three main groups. These correspond closely with geography as follows: (1) most of the rivers from North Island; (2) all the rivers from north-east coast of South Island; (3) most of the rivers from the remainder of South Island. Elemental analyses of their sediments also led to a geographical grouping of rivers. Six main groups resulted from a Q-mode cluster analysis of elemental compositions. These were; the northernmost river (Wairoa River); the east coast of North Island; the west coast of North Island; the east coast of South Island; the southeast and west coasts of South Island; the west coast of South Island. There is substantial overlap between the groupings by clay mineralogy and by composition. The results can be interpreted mainly in terms of the geologies of source areas. Exceptions to regional trends reflect either an unusual geology in the source areas or low sediment loads, where soils contribute significantly to the sediments. The terrigenous component of offshore sediments and New Zealand riverine sediments have similar compositions, suggesting that the former are derived in a relatively unmodified form from riverine sediments. (Author's abstract)
W89-06314

COMPARISON OF PLASMID DISTRIBUTION IN SEDIMENT BACTERIA ISOLATED FROM CLEAN AND NAPHTHALENE POLLUTED SITES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
For primary bibliographic entry see Field 5C.
W89-06330

DISTRIBUTION AND COMPOSITION OF THE SURFICIAL SEDIMENTS OF GEORGIAN BAY AND NORTH CHANNEL,
International Joint Commission-United States and Canada, Windsor (Ontario).
For primary bibliographic entry see Field 2H.
W89-06337

GEOLOGY AND ENVIROMENTAL SIGNIFICANCE OF SEDIMENT DISTRIBUTIONS IN AN AREA OF THE SUBMERGED NIAGARA ESCARPMENT, GEORGIAN BAY,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W89-06338

CHEMISTRY OF BOTTOM SEDIMENTS IN LAKE MUTEK INDUCED BY ARTIFICIAL AERATION (CHEMIZM OSADOW DENNYCH JEZIORA MUTEK PODDANEGO EKSPERYMENTOWI SZTUCKZNEGO NAPOWIETRZANIA),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06358

SEASONAL VARIATION IN FAUNAL DISTRIBUTION WITHIN THE SEDIMENTS OF A CANADIAN SHIELD STREAM, WITH EMPHASIS ON RESPONSES TO SPRING FLOODS,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 2E.
W89-06381

TEMPORAL AND SPATIAL TRENDS IN METAL LOADS TO SEDIMENTS OF LAKE SIMCOE, ONTARIO,
Department of Fisheries and Oceans, Owen Sound (Ontario). Great Lakes Fisheries Research Branch.
For primary bibliographic entry see Field 5B.
W89-06391

COMPREHENSIVE GENERALIZED STUDY OF SCOUR AT CANTILEVERED PIPE OUTLETS: PART I. BACKGROUND,
Agricultural Research Service, Stillwater, OK. Water Conservation Structures Lab.
For primary bibliographic entry see Field 8B.
W89-06397

HANDY IMPACT CORER FOR SAMPLING LAKE SURFACE SEDIMENT,
National Inst. for Environmental Studies, Ibaraki (Japan).
For primary bibliographic entry see Field 7B.
W89-06436

LABORATORY EXPERIMENTS ON RESISTANCE TO OVERLAND FLOW DUE TO COMPOSITE ROUGHNESS,
Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.
G. Rauws.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 37-52, November 15, 1988. 7 fig, 2 tab, 20 ref.

Descriptors: *Resistance, *Overland flow, *Flow friction, *Hydraulic roughness, *Erosion, Flow, Hydraulics, Slopes, Thin films, Algorithms, Sediment transport, Friction, Mathematical analysis.

Grain shear stress is an important parameter in the process of sediment transport on irregular beds. The concept of dividing total shear stress in its components is a promising tool in erosion modeling in a wide range of field situations. It was necessary that the concepts of Einstein and Banks be verified for thin water films on steep slopes. No sufficient theoretical background is available to proof the basic equations. Therefore, simple experiments were executed in laboratory flumes. The experiments show that flow friction attributed to a certain roughness element is to a large extent independent of the presence of other roughness elements, if these roughness elements are superimposed. The contribution of grain friction and form friction to total friction strongly varies with bed slope and Reynolds number. This means that constant coefficients to calculate one of these factors cannot be used in a wide range of flow conditions. Literature data confirm applicability of Savat's algorithm for different bed roughness types. However, flow friction on irregular beds seems to be fundamentally different. Further research to predict flow parameters on such beds indicated that hydraulic parameters and roughness coefficients on irregular beds are to a lesser degree dependent on the slope than is the case of plane beds. Since Manning coefficients for thin water films are far from constant, the variation of the Darcy-Weisbach friction coefficient with Reynolds number, bed slope, and bed roughness has to be studied. (Doria-PTT)
W89-06510

NATURE OF THE DISSOLVED LOAD OF THE KRISHNA RIVER BASIN, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
For primary bibliographic entry see Field 2K.
W89-06517

GENERAL FUNDAMENTALS OF THE STUDY OF THE BIOLOGICAL PRODUCTIVITY OF WATER BODIES(OBSHCHIE OSNOVY UCHENIYA O BIOLOGICHESKOI PRODUKTIVNOSTI VODOEMOV),
Akademiya Nauk SSSR, Leningrad. Zoologicheskii Inst.
A. F. Alimov.
Gidrobiologicheski Zhurnal GBZUAM, Vol. 24, No. 3, p 40-51, 1988. 1 fig, 2 tab, 38 ref. English summary.

Descriptors: *Limnology, *Lakes, *Reservoirs, *Productivity, *USSR, Ecosystems, Hydrobiology.

Patterns which were determined by analysis of biotic balances observed by various investigators in lakes and reservoirs of the Soviet Union are described. A general scheme of energy fluxes in water ecosystems was developed. The necessity of studying the patterns in the formation and structure of substances, energy and information fluxes in water ecosystems is emphasized. This will permit an understanding of the mechanisms of how these systems function. (Author's abstract)
W89-06570

INTERACTION OF FINE SEDIMENT WITH ALLUVIAL STREAMBEDS,
Geological Survey, Reston, VA. Water Resources Div.
H. E. Jobson, and W. P. Carey.
Water Resources Research WRERAQ, Vol. 25, No. 1, p 135-140, January 1989. 6 fig, 15 ref.

Descriptors: *Sediment transport, *Alluvial deposits, *Path of pollutants, *Silt, Alluvial rivers, Clay, Suspended sediments, Reviews, Streambeds.

More knowledge is needed about the physical processes that control the transport of fine sediment moving over an alluvial bed. The knowledge is needed to design rational sampling and monitoring programs that assess the transport and fate of toxic substances in surface waters because the toxics are often associated with silt- and clay-sized particles. Research in areas that may help to improve understanding of the processes involved is reviewed. An alluvial streambed can have a large capacity to store fine sediments that are extracted from the flow when instream concentrations are high and it can gradually release fine sediment to the flow when the instream concentrations are low. Several types of storage mechanisms are available depending on the relative size distribution of the suspended load and bed material, as well as the flow hydraulics. Alluvial flow tends to segregate the deposited material according to size and density. Some of the storage locations are temporary, but some can store the fine sediment for very long periods of time. (Author's abstract)
W89-06588

PLANT-SOIL-WATER RELATIONSHIPS IN LAS VEGAS WASH,
Bureau of Reclamation, Boulder City, NV. Lower Colorado Region.
For primary bibliographic entry see Field 2G.
W89-06624

FATE AND TRANSPORT OF SEDIMENT-ASSOCIATED CONTAMINANTS,
Environmental Research Lab., Athens, GA.
For primary bibliographic entry see Field 5B.
W89-06639

1982 DETROIT MICHIGAN AREA SEDIMENT SURVEY,
Environmental Protection Agency, Chicago, IL. Great Lakes National Program Office.
For primary bibliographic entry see Field 5A.
W89-06654

DETERMINATION OF ORGANIC CHEMICALS IN SEDIMENTS TAKEN FROM THREE UNPOLLUTED ESTUARIES IN SOUTHWEST ENGLAND,
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
B. J. Harland, and R. W. Gowling.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 103-107. 4 fig, 5 ref.

Descriptors: *Water quality, *Estuaries, *Organic wastes, *Lake sediments, Effluents, Domestic

wastes, Animal wastes, Organic compounds, Sediment sampler, Wastewater pollution.

Sediment samples from three relatively unpolluted estuaries in Southwest England were examined. All three estuaries (those of the rivers, Dart, Exe and Teign) drain predominantly agricultural land and receive only low volumes of primarily domestic effluents. The results of this investigation have shown that the major components in the samples are of biogenic origin. They include components of the leaf waxes of higher plants (nC(27), nC(29), and nC(31) alkanes), a long chain (C(26)) alcohol and sterols. Two of the latter, coprostanol and cholesterol, probably originate from sewage or animal waste discharges to estuaries. (See also W89-06748) (Author's abstract)
W89-06763

SEDIMENT-WATER PARTITION COEFFICIENTS OF HYDROPHOBIC CHEMICALS IN THE PRESENCE OF THIRD PHASE MATERIAL,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
For primary bibliographic entry see Field 5B.
W89-06771

SEDIMENTATION SURVEY OF FENA RESERVOIR, GUAM, MARIANA ISLANDS, 1979,
Geological Survey, Honolulu, HI. Water Resources Div.
W. F. Curtis.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4125, July 1984. 15p, 8 fig, 1 tab, 5 ref.

Descriptors: *Sedimentation, *Fena Reservoir, *Surveys, *Guam, *Reservoir silting, Reservoir capacity, Bathymetry, Particle size, Suspended sediment.

Fena Reservoir, in south-central Guam, was constructed in 1950-51 to provide a dependable water supply for the U.S. Navy. At the request of the U.S. Navy, the U.S. Geological Survey conducted a sedimentation survey of the Fena Reservoir during the months of November and December 1979. The sedimentation survey showed that at the spillway elevation, the reservoir has a surface area of 195 acres and a volume of 7,863 acre-ft. Data from a network of 30 triangulation stations and 32 cross sections indicated a decrease of 440 acre-feet in reservoir capacity since 1949 due to the accumulation of sediment. Area capacity curves for 1949, 1973, and 1979 and a bathymetric map of the reservoir were constructed. The combination of denser water due to lower temperature and suspended sediment load appears to create a density current within the reservoir. Particle size analyses and unit-weight computation are provided to define the physical characteristics of the accumulated sediment. (Author's abstract)
W89-06860

STREAMFLOW GAIN-AND-LOSS AND SUSPENDED-SEDIMENT CHARACTERISTICS OF THE SOUTH PLATTE RIVER AND THREE IRRIGATION CANALS NEAR FORT MORGAN, COLORADO,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06865

NUMERICAL ANALYSIS OF SEDIMENT TRANSPORT IN SHALLOW WATER,
California Univ., Santa Barbara.
C. K. Ziegler.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8711506. Ph.D. Dissertation. 1986. 208p, 76 fig, 21 ref, 2 append.

Descriptors: *Sedimentation, *Model studies, *Numerical analysis, *Sediment transport, *Shallow water, *Suspended sediments, Mathematical models, Finite difference methods, Computer programs, Hydrodynamics, California, Raisin River.

A numerical model was developed to simulate the transport processes of fine-grained, cohesive sediments in shallow water. Improved finite difference equations were also developed to model the hydrodynamics and dispersion of suspended sediment. A volume integral method was used to derive difference equations which are second-order accurate, explicit, and conservative. The model can treat open boundary conditions, it is quite general, and it can also treat problems with variable geometry and bottom depth. A computer model is demonstrated in two applications: (1) the effects of variable bottom topography are studied in a calculation of sediment transport in the Raisin River; and (2) the depositional patterns of suspended sediment particles of varying sizes are examined for a river flowing into a lake with a cross-flow. (Cremmins-AEPCO)
W89-06955

2K. Chemical Processes

SIMULTANEOUS NITRIFICATION AND DENITRIFICATION IN AEROBIC CHEMOSTAT CULTURES OF THIOSPHAERA PANTOTROPHA,
Technische Hogeschool Delft (Netherlands). Lab. of Microbiology and Enzymology.
For primary bibliographic entry see Field 2H.
W89-05798

STABLE CARBON AND NITROGEN ISOTOPE BIOGEOCHEMISTRY IN THE DELAWARE ESTUARY,
Delaware Univ., Lewes. Coll. of Marine Studies.
For primary bibliographic entry see Field 2L.
W89-05803

FLUXES AND REACTIVITIES OF ORGANIC MATTER IN A COASTAL MARINE BAY,
Washington Univ., Seattle. School of Oceanography.
For primary bibliographic entry see Field 2L.
W89-05805

CHEMICAL QUALITY OF MATERNAL DRINKING WATER AND CONGENITAL HEART DISEASE,
Brown Univ., Providence, RI. Div. of Biological and Medical Sciences.
For primary bibliographic entry see Field 5C.
W89-05869

DISSOLVED IODINE BEHAVIOR IN ESTUARIES ALONG THE EAST COAST OF THE UNITED STATES,
Delaware Univ., Lewes. Coll. of Marine Studies.
W. J. Ullman, G. W. Luther, R. C. Aller, and J. E. Mackin.
Marine Chemistry MRCHBD, Vol. 25, No. 2, p 95-106, October 1988. 4 fig, 40 ref. National Science Foundation Contracts OCE-83-09551, OCE-86-1616, OCE-83-10407, OCE-86-96121, and OCE-87-17343; Petroleum Research Fund Contract PRF-20096-G2.

Descriptors: *Estuaries, *Iodine, *Geochemistry, Mineralization, Organic matter, Sediments, Bottom water, Interstitial water, Chesapeake Bay, Delaware Bay, Winyah Bay.

Previous studies of dissolved iodine behavior in estuaries have shown no evidence of iodine's participation in biogeochemical processes. Three estuaries along the Atlantic coast (Chesapeake Bay, Delaware Bay, Winyah Bay) clearly show the results of iodine reactivity in biological and/or particle processes. Major factors involved in controlling the iodine speciation and distribution in estuaries include: (i) remineralization of iodine-containing organic matter in sediment or anoxic bottom water; (ii) anthropogenic inputs; (iii) resuspension of fine-grained sediments and their associated interstitial water; and (iv) estuarine flow regime and residence time. (Author's abstract)
W89-05906

SEASONAL TRENDS OF ALUMINUM CHEMISTRY IN A SECOND-ORDER MASSACHUSETTS STREAM,
Syracuse Univ., NY. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-05926

ELECTRON MICROSCOPY OF NANOMETER PARTICLES IN FRESHWATER,
Nagoya Univ. (Japan). Faculty of Engineering.
T. Nomizu, K. Goto, and A. Mizuik.
Analytical Chemistry ANCHAM, Vol. 60, No. 23, p 2653-2656, Dec 1 1988. 4 fig, 9 ref.

Descriptors: *Electron microscopy, *Particle size, *Aquatic environment, *Particulate matter, Seawater, Wastewater, Heavy metals, Particle shape, Sample preparation, Ponds, Rivers, Adsorption, Sedimentation, Centrifugation, Toxicity.

The usefulness of specimen preparation by centrifugation in the characterization of particles smaller than 100 nm in pond and river waters using the analytical electron microscope is described. Adhesion of particles to a carbon film is essential to quantitatively collect particles in this technique. Nanometer particles, 1-100 nm, in freshwater play an important role in decreasing the toxicity of heavy metals toward aquatic organisms by adsorption. They are also known to contribute to sedimentation of heavy metals in estuarine regions. So far, however, little information has been available on the morphology and elemental composition of individual particles. To evaluate the collection of nanometer particles on the carbon film, a monodispersed gold suspension was used, which was prepared by mixing 90 ml of 0.11 microg of Au per ml of gold(III) chloride solution with 10 ml of 0.2 mM sodium citrate. The prepared suspension was directly sedimented on a carbon film by centrifugation without preliminary filtration through a 0.1 micron-pore filter. Density difference between gold and colloidal particles in freshwaters does not affect diffusion phenomena of nanometer particles, although a difference in adhesion to the film between the two is uncertain. Thus particles larger than 10 nm in freshwaters can be collected nearly quantitatively under the prescribed conditions. The proposed technique can also be applied to electron microscopic characterization of nanometer particles in various solutions, especially those containing salts, such as seawater and wastewater. (Miller-PTT)
W89-05952

EFFECTS OF SIMULATED ACID RAIN ON SOIL AND LEACHATE ACIDIFICATION OF A LEXINGTON SILT LOAM,
California Univ., Berkeley. Dept. of Plant and Soil Biology.
For primary bibliographic entry see Field 5C.
W89-06012

SORPTION BEHAVIOUR OF WASTE-GENERATED TRACE METALS IN ESTUARINE WATERS,
Plymouth Polytechnic (England). Inst. of Marine Studies.
For primary bibliographic entry see Field 5B.
W89-06026

STATISTICAL APPROACH TO ASSESS FACTORS AFFECTING WATER CHEMISTRY USING MONITORING DATA,
North Texas State Univ., Denton. Inst. of Applied Sciences.
For primary bibliographic entry see Field 5B.
W89-06057

SIMULATED TRANSPORT OF MULTIPLE CATIONS IN SOIL USING VARIABLE SELECTIVITY COEFFICIENTS,
Florida Univ., Gainesville. Dept. of Soil Science.
R. S. Mansell, S. A. Bloom, H. M. Selim, and R. D. Rhue.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1533-1540, November-December

1988. 5 fig, 4 tab, 17 ref.

Descriptors: *Water chemistry, *Leaching, *Path of pollutants, *Soil water movement, *Solute transport, *Cations, *Loam, Chromatography, Effluents, Breakthrough curves, Model studies, Yolo, Pore volumes, Magnesium, Sodium, Mathematical models.

A chromatographic model for describing the transport of multiple cations in soil was modified to include both mobile-immobile flow regions and variable ion exchange selectivity coefficients K (sub ij) for each binary combination of cation species in a ternary soil-water system. The model was evaluated by comparing simulated results with published breakthrough curves (BTC) for Na (+) and Mg (2+) concentrations in effluent from columns of Yolo loam soil initially saturated with Ca (2+) ions. Experimental BTC for the relatively uncompetitive Na + species were adequately described when either constant or variable values of K (sub ij) were used in the model. For the more competitive Mg (2+) species however, simulations using constant K (sub ij) coefficients described the relative location for maximum concentration but underestimated tailing for the BTC. When all of the soil solution was assumed to be mobile, description of tailing for Mg (2+) BTC was improved by the use of variable K (sub ij) values in simulations, but retardation for MG (2+) transport tended to be overestimated. The combined use of mobile-immobile liquid regions and of variable selectivity coefficients provided the observed tailing in Mg (2+) BTC but minimized overestimation of retardation. (Author's abstract)
W89-06070

INDEPENDENT CALIBRATION OF MECHANISTIC-STOCHASTIC MODEL FOR FIELD-SCALE SOLUTE TRANSPORT UNDER FLOOD IRRIGATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
D. B. Jaynes, R. C. Rice, and R. S. Bowman.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1541-1546, November-December 1988. 5 fig, 2 tab, 33 ref.

Descriptors: *Path of pollutants, *Soil water, *Solute transport, *Flood irrigation, *Leaching, Infiltration rate, Interstitial water, Model studies, Hydrodynamics, Infiltrometers, Hydraulic properties, Mathematical models.

Solute leaching at the field scale can show considerable variability because of variations in the hydraulic properties of the soil. A simple mechanistic-stochastic model for predicting solute transport on this scale during intermittent flood irrigation is described and a method of calibrating the model independent of any leaching measurements is presented. The model assumes that the pore water velocity varies horizontally across the field but is uniform in the vertical direction. Explicit expressions for chemical diffusion and hydrodynamic dispersion are not included in the model. Instead, horizontal variations in the velocity serve to disperse the solute when measured on a field wide basis. The model requires knowledge of the probability density function for the velocity and estimates of the function parameters. These parameters were estimated from variations in infiltration rates measured within 63 ring infiltrometers and from water retention data. Model simulations of Br leaching agreed well with most measured data for both position of the tracer peak and the degree of solute spreading, indicating that at least under flood irrigation, variations in infiltration as controlled by soil hydraulic properties explain most of the observed variations in Br leaching over a field. (Author's abstract)
W89-06071

SOLUBILITY OF BARIUM ARSENATE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
For primary bibliographic entry see Field 5B.
W89-06075

PHOSPHORUS ADSORPTION BY KAOLINITE AND MONTMORILLONITE: I. EFFECT OF TIME, IONIC STRENGTH, AND PH,
Volcani Inst. of Agricultural Research, Bet-Dagan (Israel). Inst. of Soil and Water.
B. Bar-Yosef, U. Kafkafi, R. Rosenberg, and G. Sposito.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1580-1585, November-December 1988. 6 fig, 1 tab, 26 ref. US-Israel Binational Agricultural R & D Grant I-401-82.

Descriptors: *Phosphates, *Soil solution, *Adsorption, *Phosphorus, *Soil types, Calcium, Potassium, Kaolinite, Montmorillonite, Hydrogen ion concentration, Solubility, Solute Transport.

Phosphate reactions in soils are affected by various factors operating simultaneously. Specific effects of total phosphate partitioning between solid and solution phases of calcium and potassium kaolinite and montmorillonite suspensions were studied as model systems of soils containing these minerals. Phosphorus concentration in the solution phase stabilized within 24 to 48 hours after its introduction into the system. Increased electrolyte concentration, which elevated the electrical conductivity from 0.2 to 5.0 dS/m, decreased in the solution phase in both clay systems. Further increase to about 40 dS/m had a negligible effect on the solution phase. Phosphorus adsorption by calcium clay exceeded that by potassium clay. This, and the effect of the electrical conductivity on the solution phase operate via their effect on the extent of the diffuse double layer, which determines the accessibility of phosphate to adsorption sites on the edges of the clay. Phosphorus solution concentration as a function of pH was minimal in the studied clays around pH 6. In the investigated pH range (5-9), phosphate partitioning was controlled by adsorption, which could be described by a modified Langmuir model. The model accounts for effects of the solution phase and pH on adsorption and considers retention of individual phosphate species by the adsorbent. (Author's abstract)
W89-06077

PHOSPHORUS ADSORPTION BY KAOLINITE AND MONTMORILLONITE: II. ORGANIC ANION COMPETITION,
Agricultural Research Organization, Bet-Dagan (Israel). Inst. of Soils and Water.
U. Kafkafi, B. Bar-Yosef, R. Rosenberg, and G. Sposito.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p November-December 1988. 4 fig, 2 tab, 28 ref. US-Israel Binational Agricultural R&D Grant I-401-82.

Descriptors: *Solute transport, *Adsorption, *Phosphorus, Kaolinite, Montmorillonite, Aluminum, Citrate, Bicarbonate, Oxalate, Acetate, Amino Acids, Clays, Roots.

The mechanisms by which roots affect the release of phosphate from soil surfaces into the solution is not clear. The competition of several agents, reported as root exudates, with phosphorus on adsorption sites on kaolinite and montmorillonite was studied. The agents studied were acetate, bicarbonate, citrate and oxalate, and the amino acids phenylalanine and alpha-amino isobutyric acid. The adsorption or desorption of phosphorus on the clays in the presence of these agents at various fixed pHs and known ionic strength, and the effect of slurry density on phosphorus adsorption, were determined. Citrate, bicarbonate and oxalate decreased, and acetate and the amino acids increased phosphorus adsorption to the clays. A decrease in the solution to clay ratio from 100 to 10 L/kg resulted in enhanced phosphorus adsorption. The unifying principle that explains these findings is that phosphorus adsorption on a clay depends on the extent of the depression of the negative potential of the clay platelets. Bicarbonate and citrate anions at pH greater than 8 compete with phosphorus for active aluminum sites on the clay. The increased phosphorus adsorption in the presence of amino acids is suggested to stem from the fact that H-bonding of the amino groups causes a decrease in interlamellar spacing, and produces quasicrystals. The quasicrystals reduce the spillover of negative charge from the surface to the edges and allow closer approach of the phosphate ion to the aluminum site. (See also W89-06077) (Author's abstract)
W89-06078

MINERALIZATION OF PHOSPHORUS IN SLUDGE-AMENDED SOILS MONITORED BY PHOSPHORUS-31-NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 5E.
W89-06079

DYNAMICS OF ALUMINUM COMPLEXATION IN MULTIPLE LIGAND SYSTEMS,
Savannah River Ecology Lab., Aiken, SC. Div. of Biogeochemistry.
For primary bibliographic entry see Field 5B.
W89-06080

DENITRIFICATION HYSTERESIS DURING WETTING AND DRYING CYCLES IN SOIL,
Rhode Island Univ., Kingston. Dept. of Natural Resources Science.
P. M. Groffman, and J. M. Tiedje.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1626-1629, November-December 1988. 2 fig, 2 tab, 32 ref. NSF Grant BSR-83-18387.

Descriptors: *Hysteresis, *Soil water, *Denitrification, *Moisture density, Wetting, Porosity.

Denitrification response to soil moisture was studied in soils undergoing either wetting or drying cycles to determine if denitrification soil water relationships were independent of antecedent moisture conditions. Intact, field moist soil cores were subjected to either wetting or drying phase treatments in the laboratory. In the drying phase treatment, soils were wet to saturation and then progressively dried to field capacity, 60% water filled porosity and 20% water filled porosity with denitrification measured at each moisture condition. In the wetting phase treatment, soil cores were dried to 20% water filled porosity and were then progressively wet to 60% water-filled porosity, field capacity, and saturation. Denitrification showed a hysteretic response to soil moisture when drying and wetting phases were compared. In the drying phase, rates of denitrification decreased as soils were dried from saturation to field capacity, with further decreases in activity observed at 60 and 20% water-filled porosity. In the wetting phase, soils from 20 to 60% water-filled porosity, with only slight increases observed as soils were wet further to field capacity and saturation. The hysteretic response was observed in three soils of markedly different texture. Denitrification dynamics in the wetting phase were strongly correlated with pulses of C and N mineralization caused by stress of microbial biomass by drying and rewetting. Models of denitrification driven by soil moisture need to consider hysteretic effects if they are to accurately predict denitrification activity in the field. (Author's abstract)
W89-06083

VERTICAL DISTRIBUTION IN SOIL OF UNINCORPORATED SURFACE-APPLIED PHOSPHORUS UNDER SPRINKLER IRRIGATION,
Agricultural Research Service, Prosser, WA.
For primary bibliographic entry see Field 3F.
W89-06084

BICARBONATE ESTIMATION FROM ALKALINITY DETERMINATIONS FOR NEUTRAL TO ACIDIC LOW ALKALINITY NATURAL WATERS: THEORETICAL CONSIDERATIONS,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 7B.
W89-06092

LAKE ACIDIFICATION IN NORWAY: PRESENT AND PREDICTED CHEMICAL STATUS,

Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5C.
W89-06174

PATTERNS OF GROUND-WATER CHEMISTRY, ROSS CREEK BASIN, ALBERTA, CANADA,
Alberta Univ., Edmonton. Dept. of Geology.
D. U. Ophori, and J. Toth.
Ground Water GRWAAR, Vol. 27, No. 1, p 20-26, January-February 1989. 10 fig, 1 tab, 16 ref.

Descriptors: *Geochemistry, *Canada, *Water quality, *Geohydrology, *Groundwater movement, *Ross Creek Basin, *Alberta, Dissolved solids, Salinity, Groundwater recharge, Water classification, Aquifer characteristics.

On the basis of the degree of mineralization, approximately 40% of the groundwater in Ross Creek Basin may be considered as fresh (total dissolved solids, TDS, < 2,000 ppm), and 60% as brackish (2,000 < TDS < 10,000 ppm). At least 70% of the groundwater is potable within treatable limits. Major ion analyses of over 167 water samples reveal a strikingly consistent regional pattern of hydrochemistry. The hydrochemical pattern correlates with the flow pattern of groundwater in the basin. Low TDS contents, high Ca(2+):Mg(2+) ratio, low SO4(2-), and high HCO3(-) occur in recharge areas, whereas opposite conditions are associated with discharge areas. In terms of hydrochemical facies, waters of the Ca-Mg-HCO3 and Na-HCO3 types dominate in the recharge areas, whereas those of the Ca-Mg-SO4-HCO3 and Na-S)4-HCO3 types prevail in discharge areas. The hydrochemical evolutionary trends appear to be strongly related to the flow paths. (Author's abstract)
W89-06200

MULTIVARIATE ANALYSIS IN HYDROCHEMISTRY: AN EXAMPLE OF THE USE OF FACTOR AND CORRESPONDENCE ANALYSES,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
E. J. Usunoff, and A. Guzman-Guzman.
Ground Water GRWAAR, Vol. 27, No. 1, p 27-34, January-February 1989. 6 fig, 21 ref.

Descriptors: *Geochemistry, *Water chemistry, *Statistical methods, *Multivariate analysis, *Water quality, *Hydrochemistry, *Geohydrology, Alberta, Arizona, Factor analysis, Correspondence analysis, Mathematical studies, Sulfates, Fluorides, Aquifer characteristics.

Statistically-based, semiquantitative techniques (Factor Analysis, FA, and Correspondence Analysis, CA) were applied to chemical data from two regional aquifers (Milk River, Alberta, Canada, and San Pedro River, Arizona) to assess the usefulness of such techniques at the initial stages of hydrochemical studies. For the Milk River aquifer, both FA and CA defined three factors to account for the major ion variations observed, namely, sulfate reduction occurring in the recharge area and mixing of waters of different ages in the deeper portions of the aquifer, ion-filtration processes, and ion exchange on clays. For the FA, the comparison between varimax and oblique rotations led to similar interpretations. For the San Pedro River basin, FA (Q-mode) extracted two factors that helped segregate waters from the two aquifers in the area. The CA, applied only to samples from the confined aquifer, drew two factors that were related to dissolution of gypsum coupled with ion exchange (softening) as the main mechanisms operating in the aquifer, along with a hypothetical presence of fluorite in the aquifer sediments to justify the rather high F(-) observed in local groundwaters. Comparisons made between these results presented and the findings of earlier studies are in reasonably good agreement. However, using FA and CA offers the advantages of a shorter execution time and a greater objectivity in the presentation of preliminary results. (Rochester-PTT)
W89-06201

DISSOLVED INORGANIC CARBON IN THE TUCSON BASIN AQUIFER,
Arizona Univ., Tucson. Dept. of Geosciences.
S. Rose, and A. Long.
Ground Water GRWAAR, Vol. 27, No. 1, p 43-49, January-February 1989. 5 fig, 1 tab, 21 ref.

Descriptors: *Geochemistry, *Water chemistry, *Alkalinity, *Carbonates, *Tucson Basin Aquifer, *Arizona, *Dissolved inorganic carbon, *Carbon dioxide, Aquifer characteristics, Groundwater recharge, Detritus, Decomposing organic matter, Surface-groundwater relations, Calcite, Geohydrology, Phreatophytes.

The concentration of dissolved inorganic carbon (DIC) species and the other major ionic constituents were determined at 45 sampling locations within the Tucson basin aquifer (Arizona). The distribution and concentration of the various inorganic carbon species were related to the hydrogeological characteristics of the principal recharge zones within this alluvial basin. Bicarbonate alkalinity concentrations were highest subjacent to a floodplain where calcite and other relict salts likely precipitated in the shallow subsurface under past pluvial conditions. Calculated partial pressure of carbon dioxide (PCO2) values were highest where the water table is sufficiently elevated to support phreatophyte growth. The regional distribution of PCO2 suggests that the generation of CO2 is limited to the oxidation of influent plant detritus below the stream channels. The alkalinization of Tucson basin groundwater is ultimately constrained by this limited production of CO2. The dissolution of calcite in young groundwater (<200 yr) and the precipitation of calcite in deeper, more chemically evolved groundwater likely represent other important controls on DIC concentrations. (Author's abstract)
W89-06203

COPRECIPITATION OF PHOSPHATE WITH CALCITE IN LAKE WATER: A LABORATORY EXPERIMENT MODELLING PHOSPHORUS REMOVAL WITH CALCITE IN LAKE CONSTANCE,
Konstanz Univ. (Germany, F.R.). Limnological Inst.
J. Kleiner.
Water Research WATRAG, Vol. 22, No. 10, p 1259-1265, October 1988. 5 fig, 1 tab, 28 ref, 2 plates. Deutsche Forschungsgemeinschaft Special Grant 'Sonderforschungsbereich Stoffhaushalt des Bodensees (SFB 248)'.

Descriptors: *Lakes, *Mathematical models, *Limnology, *Water chemistry, *Nutrients, *Phosphorus removal, *Calcite, *Crystallization, *Chemical precipitation, Coprecipitation, Precipitation, Natural waters, Crystal growth, Chemical reactions, Epilimnion, Kinetics, Lake Constance.

The precipitation of calcite from natural lake water was studied in laboratory experiments under controlled conditions; water from Lake Constance filtered through 0.2 micrometer membranes was used. Temperature was 15 C; saturation index was adjusted to about 50; and calcium carbonate seed crystals of defined particle size were added. The reaction kinetics were monitored as graphs of d(Ca)/dt (or: d(pH)/dt, d(alkalinity)/dt, d(conductivity)/dt), revealing that reaction rates depended on the seed crystal concentration. During the growth of calcite crystals, the phosphate coprecipitation rate depended on the crystallization velocity. Field data were used in a model calculation, as were data derived from coprecipitation experiments. From the rate law of coprecipitation of phosphate with calcite evaluated in these experiments, the potential impact of autochthonous calcite precipitation on the epilimnic phosphorus content of Lake Constance was estimated. About 35% of the total P removal was calculated to be coprecipitated with calcite. (Author's abstract)
W89-06222

INFLUENCE OF METAL IONS RELEASED BY AN ACTIVATED CARBON ON THE ADSORPTION OF ORGANICS: THE ROLE OF CALCIUM IONS (INFLUENCE DES IONS METALLIQUES LIBERES PAR UN CHARBON ACTIF SUR L'ADSORPTION DE MICROPOLLUANTS ORGANIQUES: LE ROLE DES IONS CALCIUM),
Limoges Univ. (France). Lab. de Genie Chimique, Traitement des Eaux.
For primary bibliographic entry see Field 5F.
W89-06230

ADSORPTION OF PYRIDINE ONTO SPENT RUNDLE OIL SHALE IN DILUTE AQUEOUS SOLUTION,
Queensland Univ., Brisbane (Australia). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-06231

GENERALIZED SOFT WATER ACIDIFICATION MODEL,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-06255

CALCITE-CARBON EQUILIBRIUM IN SOIL WATER SAMPLES,
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
For primary bibliographic entry see Field 7B.
W89-06282

EFFECTS OF GLACIAL ICE ON SUBSURFACE TEMPERATURES OF HYDROTHERMAL SYSTEMS IN YELLOWSTONE NATIONAL PARK, WYOMING: FLUID-INCLUSION EVIDENCE,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 2F.
W89-06291

SEASONAL VARIATION OF PHOSPHORUS RELEASE FROM THE SEDIMENTS OF SHALLOW LAKE BALATON (HUNGARY),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 2H.
W89-06293

EXTERNAL MASS TRANSPORT PROCESSES DURING THE ADSORPTION OF DYES ONTO BAGASSE PITH,
Queen's Univ., Belfast (Northern Ireland). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-06300

NON-BIOLOGICAL EVOLUTION, IN WATER, OF SOME THREE- AND FOUR-CARBON ATOM ORGANOHALOGENATED COMPOUNDS: HYDROLYSIS AND PHOTOLYSIS (EVOLUTION NON BIOLOGIQUE DANS L'EAU DE COMPOSES ORGANOHALOGENES A TROIS ET QUATRE ATOMES DE CARBONE: HYDROLYSE ET PHOTOLYSE),
Universite de Toulon et du Var, La Garde (France). Lab. de Chimie Appliquee.
For primary bibliographic entry see Field 5F.
W89-06303

ADSORPTION OF TRACE METALS ON ALUMINIUM OXIDE: A SIMULATION OF PROCESSES IN FRESHWATER SYSTEMS BY CLOSE APPROXIMATION TO NATURAL CONDITIONS,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5B.
W89-06305

GENERATION AND DECAY OF HYDROGEN PEROXIDE IN ESTUARINE WATERS,
Australian Nuclear Science and Technology Organisation, Sutherland.

R. Szymczak, and T. D. Waite.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 39, No. 3, p 289-299, 1988. 9 fig, 2 tab, 25 ref. Australian Marine Sciences and Technologies Grants Scheme Grant 85/0933.

Descriptors: *Estuaries, *Hydrogen peroxide, *Oxidation, *Chemical reactions, *Solar radiation, Chemical degradation, Estuarine environment, Chemical analysis.

Apart from its central role in photosynthesis, one of the most dramatic effects of light in marine and freshwater systems is its ability to generate reactive chemical intermediates. Of these, hydrogen peroxide is one of the more stable and easily detected. Aspects of the generation and decay of hydrogen peroxide in the Port Hacking River estuary, New South Wales, have been investigated in a number field and laboratory studies. Peroxide concentrations in surface waters in the early morning are relatively uniform over the estuary and typically less than 35 nM, whereas concentrations in mid-afternoon in excess of 100 nM have been observed. Variation of peroxide concentration with depth in the deep basins of Port Hacking is dependent on the extent of structure within the water column, with little mixing of surface-generated peroxide into poorly-illuminated bottom waters under stratified conditions. Laboratory studies confirmed that light induces the production of hydrogen peroxide, the initial rate of production increasing with increasing molar absorptivity of the filtered water sample. Filtration of samples had little effect on the generation of hydrogen peroxide but dramatically reduced the rate of decay of photogenerated hydrogen peroxide. (Author's abstract)
W89-06328

RESPONSE OF ARMERIA MARITIMA (MILL.) WILLD. AND PLANTAGO MARITIMA L. FROM AN IRISH SALT MARSH TO NITROGEN AND SALINITY,
Trinity Coll., Dublin (Ireland). School of Botany.
For primary bibliographic entry see Field 2L.
W89-06334

CHEMICAL LIMNOLOGY OF GEORGIAN BAY AND THE NORTH CHANNEL BETWEEN 1974 AND 1980,
Ontario Ministry of the Environment, Toronto. Hazardous Contaminants Coordination Branch.
For primary bibliographic entry see Field 2H.
W89-06339

MAGNITUDE OF BLUE-GREEN ALGAL BLOOMS IN A SALINE DESERT LAKE EVALUATED BY REMOTE SENSING: EVIDENCE FOR NITROGEN CONTROL,
Arizona State Univ., Tempe. Dept. of Zoology.
For primary bibliographic entry see Field 2H.
W89-06378

SEDIMENT CONTROL OF SOLUBLE REACTIVE PHOSPHORUS IN HOXIE GORGE CREEK, NEW YORK,
State Univ. of New York Coll. at Cortland. Dept. of Biological Sciences.
For primary bibliographic entry see Field 2E.
W89-06384

ATMOSPHERIC DEPOSITION EFFECTS ON THE CHEMISTRY OF A STREAM IN NORTHEASTERN GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-06388

AIRBORNE TRANSPORT OF SULPHUR: IMPACTS ON CHEMICAL COMPOSITION OF RIVERS ON NORTH SHORE OF THE ST. LAWRENCE RIVER (QUEBEC),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5B.
W89-06390

GAS CHROMATOGRAPHIC DETERMINATION OF VOLATILE SULFIDES AT TRACE LEVELS IN NATURAL FRESHWATERS,
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
For primary bibliographic entry see Field 5A.
W89-06407

INFLUENCE OF SUSPENDED PARTICULATE MATTER REGIME ON THE HEAVY METAL POLLUTION OF THE TIDAL RIVER ELBE AT HAMBURG,
Umweltbundesamt, Berlin (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W89-06417

ORIGIN AND GENESIS OF PHOSPHATE CONTENT IN THE MINERAL SPRINGS OF PECHBRUNN/OBERPFALZ,
Technische Univ. Muenchen (Germany, F.R.). Inst. fuer Wasserchemie und Chemische Balneologie.
M. Baumann, and K. Quentin.
Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 252-255, December 1988. 4 tab, 1 fig, 9 ref. English summary.

Descriptors: *Geochemistry, *Springs, *Mineral springs, *Phosphates, *Geohydrology, *Germany, Nutrients, Fertilizers, Pechbrunn/Oberpfalz.

An investigation of the mineral springs at Pechbrunn/Operpfalz shows that the high contents of phosphate in drilled springs are not related to human fertilization activities. The analyses of the results show that in some cases the origin could be related to natural hydrogeological processes. (Author's abstract)
W89-06420

STUDIES OF A SUBARCTIC COASTAL MARSH: II. SALINITY,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
For primary bibliographic entry see Field 2L.
W89-06460

NATURE OF SOLUTE TRANSPORT IN THE GODAVARI BASIN, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
G. Biksham, and V. Subramanian.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 375-392, November 30, 1988. 4 fig, 12 tab, 25 ref.

Descriptors: *Weathering, *Water chemistry, *Rainfall-runoff relationships, *Solute transport, *River basins, *India, Temporal distribution, Dissolved solids, Granites, Sedimentary rocks, Chemistry of precipitation, Chemical properties, Cations, Ions, Geology, Basalts.

The nature of solute transport of the Godavari basin, India, has been studied based on 59 river and four rain water samples collected four times during 1977-1980. The Godavari basin annually transports 16.8 million tons of solute load representing 6% of chemical load from the Indian subcontinent. The annual chemical erosion rate is 49 tons/km/yr after correcting for atmospheric recycling. The tributaries flowing through the Deccan traps (basalt) covering 48% of the basin area are responsible for 8% of the dissolved transport. The remaining 15% is contributed by granites and other rock types. The sedimentary rocks located in the lower part of the basin covering 7% of the basin area actually retain 7 million tons of the annual dissolved load. Individual elemental fluxes and their rates have also been calculated. Temporal variations in the dissolved transport are quite pronounced. The mean total dissolved solids of the Godavari River, 250 mg/L is much higher than the Indian and world average river water composition. (Author's abstract)
W89-06466

BIOGEOCHEMISTRY OF TWO APPALACHIAN DECIDUOUS FOREST SITES IN RELATION TO EPISODIC STREAM ACIDIFICATION,
Pennsylvania State Univ., University Park. School of Forest Resources.
For primary bibliographic entry see Field 5B.
W89-06488

ADSORPTION-DESORPTION OF ATRAZINE ON FOUR SOILS OF HYDERABAD,
Andhra Pradesh Agricultural Univ., Hyderabad (India).
For primary bibliographic entry see Field 5B.
W89-06490

NATURE OF THE DISSOLVED LOAD OF THE KRISHNA RIVER BASIN, INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
R. Ramesh, and V. Subramanian.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 139-155, November 15, 1988. 4 fig, 5 tab, 14 ref.

Descriptors: *Geochemistry, *Water chemistry, *Dissolved load, *Krishna River Basin, *India, *Solute transport, *Suspended sediments, Chemical composition, Tributaries, Rivers, River basins, River systems, River mouth, Erosion, Carbonates, Aluminum, Silicates, Mineralogy.

River water samples were collected four times during a three-year period (1981-1984) at 16 stations in the entire region of Krishna River and its major tributaries. On the basis of analytical results, the discharge weighted average chemical composition of the Krishna River was computed and compared to major river systems of the world. The total dissolved transport of Krishna to the Bay of Bengal is estimated to be 10.4 million t/yr, which accounts for 4% of the chemical load of the Indian subcontinent. The average annual chemical erosion rate at the river mouth is estimated to be 41 t/sq km/yr. The fluxes of individual dissolved species of Krishna River water to the Bay of Bengal are in the following order: $HCO3 > SO4 > Na > Cl >$ dissolved $Si > Mg > K > F > PO4$. The observed chemical data of Krishna River water were used to predict theoretically the mineral assemblages in the carbonate and in alumino-silicate systems and were compared to the observed mineralogical composition of suspended sediments. (Author's abstract)
W89-06517

DETERMINATION OF ZIRCONIUM AND HAFNIUM IN NATURAL WATERS BY ISOTOPE DILUTION MASS SPECTROMETRY,
Cambridge Univ. (England). Dept. of Earth Sciences.
For primary bibliographic entry see Field 7B.
W89-06543

ADSORPTION OF HUMIC SUBSTANCES ISOLATED FROM MARINE AND ESTUARINE SEDIMENTS,
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
B. Raspor, and P. Valenta.
Marine Chemistry MRCHBD, Vol. 25, No. 3, p 211-226, November 1988. 3 fig, 1 tab, 34 ref. NBS/IRB Project JFP-694.

Descriptors: *Humic acids, *Adsorption, *Marine sediments, *Electrochemistry, Sediments, Sedimentology, Seawater, Equilibrium, Electrodes, Estuaries, Tropical regions, Lagoons, Isotherms, Chemical composition, Molecular structure.

The adsorption of the dissolved humic substances (HS) from seawater at three differently charged electrode surfaces has been measured as the function of time and HS bulk concentration. A very sensitive electrochemical method, out-of-phase alternating current (a.c.) voltammetry, has been applied at the hanging mercury drop electrode (HMDE). The samples of HS originated from the sediments of the sea, a tropical estuary, and a lagoon, and were dissolved in seawater of pH 8.1. The equilibrium adsorption data were treated according to the Frumkin isotherm. The strength of HS adsorption at the positively charged electrode

surface depends on the aromatic composition of HS, which indicates the allochthonous, i.e., terrestrial, origin of the humic substances. At positively charged, zero charged, and negatively charged electrode surfaces, all HS investigated exhibited repulsive forces between the molecules in the adsorbed state. These repulsive forces and the strength of HS adsorption decrease as the charge of the electrode surface changes from positive through zero to negative. (Author's abstract)
W89-06544

BEHAVIOR OF PARTICULATE CARBOHYDRATES AND AMINO ACIDS IN THE ESTUARY OF THE TAMA RIVER,
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-06545

REGIONAL SCALE TRANSPORT IN A KARST AQUIFER: 1. COMPONENT SEPARATION OF SPRING FLOW HYDROGRAPHS,
California Univ., Santa Cruz. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W89-06586

EFFECTS OF HUMIC SUBSTANCES ON METAL SPECIATION,
Georgia Inst. of Tech., Atlanta. School of Geophysical Sciences.
For primary bibliographic entry see Field 5F.
W89-06668

SOME ASPECTS OF THE CHEMICAL SPECIATION OF ALUMINIUM IN ACID SURFACE WATERS,
Freshwater Biological Association, Ambleside (England).
For primary bibliographic entry see Field 5B.
W89-06683

PHYSIOLOGICAL STUDY ON THE RECOVERY OF RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) FROM ACID AND AL STRESS,
Antwerp Univ., Wilrijk (Belgium). Dept. of Biology.
For primary bibliographic entry see Field 5C.
W89-06687

BUFFERING MECHANISMS IN ACIDIFIED ALPINE LAKES,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 2H.
W89-06690

TESTING A SOIL-ORIENTED CHARGE BALANCE EQUILIBRIUM MODEL FOR FRESHWATER ACIDIFICATION,
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 5B.
W89-06694

CHANGES IN STREAMWATER CHEMISTRY AND FISHERY STATUS FOLLOWING REDUCED SULPHUR DEPOSITION; TENTATIVE PREDICTIONS BASED ON THE 'BIRKENES MODEL',
Senter for Industriforskning, Oslo (Norway).
H. M. Seip, N. Christophersen, and S. Rustad.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 149-155. 2 fig, 1 tab, 11 ref.

Descriptors: *Acid rain effects, *Water pollution control, *Water quality control, *Streams, *Stream fisheries, *Sulfur, *Model studies, *Hydrogen ion concentration, Acidic soils, Hydrologic models, Sulfates, Carbon dioxide, Aluminum, Lime, Norway, Chemical properties.

A mathematical model found to reproduce major short-term variations in water chemistry in some streams was used to obtain tentative values for pH shifts occurring after reduced sulfur deposition. By running the model for three years under various assumptions about soil acidity a large number of predicted pH shifts were calculated. The results are presented as median and 75th and 25th percentiles for present streamwater pH intervals of 0.1. For reductions in streamwater-sulfate concentrations of 30%, 50%, and 70%, the maxima for these median shifts were about 0.4, 0.7, and 1.0 pH units respectively. The predicted shifts would greatly improve the fishery status in southernmost Norway. The relationship between present pH and predicted pH shift is sensitive to several assumptions; the most important ones are: (1) Assumptions in the hydrological model, such as 'piston flow'; (2) the before-change sulfate levels that were assumed; (3) the assumption that deposition does not affect the soil lime potential; (4) assumptions about the carbon dioxide pressure; (5) the neglect of nitrate and chloride; (6) oversimplification of aluminum chemistry; and (7) the very simple way in which organic weak acids are treated. More parameters will be varied, e.g., the carbon dioxide partial pressure, present sulfate level, and parameters describing the hydrology and aluminum chemistry. (See also W89-06680) (Shidler-PTT)
W89-06695

SIMULATION OF PH, ALKALINITY AND RESIDENCE TIME IN NATURAL RIVER SYSTEMS,
Sveriges Meteorologiska och Hydrologiska Inst., Norrkoeping.
S. Bergstrom.

Descriptors: *Acid rain, *Path of pollutants, *Model studies, *Water chemistry, *Hydrogen ion concentration, *Alkalinity, River systems, Acidity, Soil chemistry, Hydrologic budget, Computer programs, Environmental effects, Hydrologic models, Saturation zone, Groundwater level, Groundwater movement, Groundwater basins.

Simulation of short-term and long-term variations in pH and alkalinity in river systems requires fundamentally different model approaches. If a model is intended only for short-term variations, the soil chemistry can be assumed to be relatively stable. This means that variation in the water balance is a major cause of variations in hydrochemistry, which permits the use of very simplistic geohydrochemical subroutines. If, on the other hand, the objective is to model long-term variations as a basis for simulations of the effects of changes in anthropogenic emissions, more advanced hydrochemical models are required. If these models include residence time of water in different geochemical environments as a significant parameter, one can no longer rely upon traditional conceptual hydrological models. The PULSE model assumes a relationship between level in the saturated zone of the model and alkalinity/acidity. Together with the water balance model this depth/alkalinity subroutine results in a generalized variation pattern of flow and acidity. As a final step, the alkalinity is transformed to pH. A more physically-based hydrological-model system with a better description of the residence time of water in a basin is outlined. Although the variation pattern is better-described by the modified model, there remains considerable uncertainty as to how to model the additional water storage and exchange correctly. (See also W89-06680) (Shidler-PTT)
W89-06696

REGIONAL AND STATE NEEDS IN SAMPLING AND ANALYTICAL METHODOLOGY,
Georgia Univ., Athens.
For primary bibliographic entry see Field 5A.
W89-06709

SEDIMENT REFERENCE MATERIALS AND THE CANADIAN MARINE ANALYTICAL CHEMISTRY STANDARDS PROGRAM,
National Research Council of Canada, Halifax (Nova Scotia). Atlantic Research Lab.
For primary bibliographic entry see Field 5A.
W89-06710

STANDARDIZED ANALYTICAL METHODS FOR EC PRIORITY POLLUTANTS,
For primary bibliographic entry see Field 5A.
W89-06751

APPLICATION OF BONDED SILICA EXTRACTION COLUMNS IN SAMPLE PREPARATION PRIOR TO THE ANALYSIS OF ORGANIC MICROPOLLUTANTS IN WATER,
Analytichem International, Cambridge (England).
For primary bibliographic entry see Field 5A.
W89-06752

CHEMOMETRICS IN ENVIRONMENTAL ANALYTICAL CHEMISTRY,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.
H. A. Van 'T Klooster.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 416-429. 1 fig, 11 ref.

Descriptors: *Computers, *Artificial intelligence, *Chemical analysis, *Organic compounds, *Quantitative analysis, Spectrometers, Chromatography, Data storage and retrieval, Statistical models, Model studies, Environmental policy, Environmental protection, Chemical properties.

In environmental analytical chemistry, chemometric tools are used in quantitative rather than in qualitative analysis. Chemometric concepts and methods for the identification of structure elucidation of organic compounds are discussed. Attention is focused on the application of computer-aided library searches and artificial intelligence to the interpretation of spectrometric and chromatographic data, whether or not combined. Library search systems for mass spectra as well as for combined ultraviolet spectra and HPLC retention data were developed based on mathematical statistical models of the reproducibility of the data involved. A pilot version of an expert system for structure analysis of organic molecules was developed based on combined infrared and mass spectral data, using artificial intelligence and information theory. The significance of the results is indicated by numerical (relative) probabilities. (See also W89-06748) (Author's abstract)
W89-06800

SELECTED CHEMICAL ANALYSES OF WATER FROM FORMATIONS OF MESOZOIC AND PALEOZOIC AGE IN PARTS OF OKLAHOMA, NORTHERN TEXAS, AND UNION COUNTY, NEW MEXICO,
Geological Survey, Oklahoma City, OK. Water Resources Div.
R. S. Parkhurst, and S. C. Christenson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4355, 1987. 222p, 2 fig, 4 tab, 6 ref.

Descriptors: *Water chemistry, *Chemical analysis, *Data collections, *Water analysis, *Pollutant identification, Dissolved solids, Ions, Temperature, Hydrogen ion concentration, Specific conductivity, Calcium, Magnesium, Potassium, Sodium, Chlorine, Sulfates, Nitrites, Alkalinity, Hardness, Chemical properties.

Hydrochemical data were compiled into a data base as part of the Central Midwest Regional Aquifer System Analysis project. The data consist of chemical analyses of water samples collected from wells that are completed in formations of Mesozoic and Paleozoic age. The data base includes data from the National Water Data Storage and Retrieval System, the Petroleum Data System, the National Uranium Resource Evaluation, and selected publications. Chemical analyses were selected for inclusion within the hydrochemical data base if the total concentration of the cations differed from the total concentration of the anions (both expressed in milliequivalents/L, by 10% or

less of the total concentration of all ions). Those analyses which lacked the necessary data for an ionic balance were included if the ratios of dissolved solids concentration to specific conductance were between 0.55 and 0.75. Selected values obtained included: pH, temperature, dissolved solids, specific conductance, hardness, and the concentrations (mg/L) of Ca, Mg, Na, Na+K, K, Cl, SO4, alkalinity, HCO3, and NO3. The tabulated chemical analyses, grouped by county, and a statistical summary of the analyses, listed by geologic unit, are presented. (Lantz-PTT)
W89-06843

CHEMICAL CHARACTERISTICS OF WATER IN THE SURFICIAL AQUIFER SYSTEM, BROWARD COUNTY, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
B. Howie.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4330, 1987. 2p, 7 fig, 2 tab, 12 ref.

Descriptors: *Water quality, *Water chemistry, *Groundwater, *Pollutant identification, *Chemical analysis, *Aquifers, *Florida, Hydrogen ion concentration, Broward County, Alkalinity, Specific conductivity, Nutrients, Iron, Manganese, Aluminum, Arsenic, Barium, Cadmium, Chromium, Lead, Zinc, Selenium, Mercury, Heavy metals, Calcium bicarbonate, Saline water intrusion, Mineralization, Water analysis.

Water quality data was collected in 1981 and 1982 during the drilling of test holes at 27 sites throughout Broward County, Florida. Determinations were made for the following physical properties and chemical constituents: pH, alkalinity, specific conductance, major ions, selected nutrients and dissolved iron, aluminum, and manganese. Determinations for the trace elements-arsenic, barium, cadmium, chromium, lead, zinc, selenium, and mercury-were made at 14 wells. Water in the surficial aquifer system between the coastal ridge and the conservation areas is potable and usually is a calcium bicarbonate type for the first 140 ft or more below land surface. Between depths of 140 and 230 ft, groundwater generally grades into a mixed-ion water type. In some areas, diluted seawater occurs beneath the mixed water zone. Dissolved iron concentrations between the coastal ridge and the conservation areas are variable but generally exceed 1,000 micrograms/L. Beneath the conservation areas and the western edge of Broward County, groundwater in the first 100 ft below land surface generally is either a calcium bicarbonate type or a mixed-ion type. At depths between 100 and 200 ft, diluted residual seawater occurs, except along the far western edge of the county. Residual seawater is least diluted in the north. Dissolved iron concentrations generally are between 300 and 1,000 micrograms/L but increase to the east of the conservation areas. Other findings of the investigation include: (1) groundwater in some areas west of the coastal ridge probably would be suitable for most domestic, agricultural, and industrial uses if it were treated for carbonate hardness; (2) groundwater in much of Broward County is chemically altered by natural softening and magnesium enrichment (natural softening increases to the west and is very pronounced beneath the far western edge of the county); and (3) there is evidence of mineralized water from the conservation areas mixing with groundwater east of the levees. (Lantz-PTT)
W89-06849

QUANTITY AND QUALITY OF STREAMFLOW IN THE WHITE RIVER BASIN, COLORADO AND UTAH,
Geological Survey, Lakewood, CO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06854

GROUND-WATER QUALITY IN WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06855

QUALITY OF GROUND WATER IN THE PUGET SOUND REGION, WASHINGTON, 1981,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-06866

MAPS SHOWING DISTRIBUTION OF DISSOLVED SOLIDS AND DOMINANT CHEMICAL TYPES IN GROUND WATER, BASIN AND RANGE PROVINCE, NEW MEXICO,
New Mexico Bureau of Mines and Mineral Resources, Socorro.
T. H. Thompson, R. Chappell, and D. L. Hart.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 83-4118-C, 1984. 5p, 5 fig, 6 tab, 11 ref.

Descriptors: *Water chemistry, *Geochemistry, *Groundwater quality, *Maps, *Dissolved solids, *New Mexico, Chemical analysis, Distribution, Geohydrology, Rocks, Lakes, Marshes, Calcium, Magnesium, Sodium, Bicarbonate, Sulfates, Chlorides, Radioactive waste disposal.

This map report is one of a series of geologic and hydrologic maps of States in the Basin and Range Province. These map reports contain information on groundwater hydrology, groundwater quality (specifically: dissolved solids, calcium, magnesium, sodium, bicarbonates, sulfates and chlorides), surface distribution of selected rock types, data on tectonic conditions, areal geophysical data, Pleistocene lakes and marshes and natural resources. This information is the basis for a summary report that characterizes the Basin and Range Province. The geologic and hydrologic characterization will be used to evaluate the Province for prospective regions for further study relative to isolation of high-level radioactive waste. (Lantz-PTT)
W89-06876

PRELIMINARY ASSESSMENT OF WATER QUALITY AND ITS RELATION TO HYDROGEOLOGY AND LAND USE: POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM, NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-06888

GROUNDWATER IN THE SOUTHEASTERN UINTA BASIN, UTAH AND COLORADO,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06892

GEOCHEMISTRY OF COPPER AND CHROMIUM ORGANIC COMPLEXES IN NARRAGANSETT BAY INTERSTITIAL WATERS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
For primary bibliographic entry see Field 2L.
W89-06931

2L. Estuaries

AQUATIC HETEROTROPHIC BACTERIA: MODELING IN THE PRESENCE OF SPATIAL AUTOCORRELATION,
Montreal Univ. (Quebec). Dept. of Biological Sciences.
For primary bibliographic entry see Field 2H.
W89-05801

STABLE CARBON AND NITROGEN ISOTOPE BIOGEOCHEMISTRY IN THE DELAWARE ESTUARY,
Delaware Univ., Lewes. Coll. of Marine Studies.
L. A. Cifuentes, J. H. Sharp, and M. L. Fogel.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1102-1115, September 1988. 11 fig, 2 tab, 54 ref. NOAA Grant NA83AA-d-0017.

Descriptors: *Delaware Bay, *Estuaries, *Carbon, *Nitrogen, *Isotope studies, *Biochemistry, *Geochemistry, Seasonal variation, Particulate matter, Organic matter, Suspended solids, Phytoplankton, Aquatic plants, Detritus, Chemical properties, Physical properties, Ammonium, Algae, Growth, Carbon dioxide, Bottom sediments, Primary productivity.

Seasonal variability in stable carbon (delta C13) and nitrogen (delta N15) isotope ratios was observed in suspended particulate matter of the Delaware estuary. Two major pools of organic matter were found in the estuary-phytoplankton growing in situ and a mixture of planktonic and terrestrial detritus. In general, the delta C13 and delta N15 of suspended particulate matter reflected planktonic dominance. With the background chemical and physical information available for the estuary, it is evident that biogeochemical processes influence isotopic distributions in the estuary to a greater extent than does physical mixing. The delta C13 values in bottom sediments were equivalent to those in suspended particulate matter, but a 2% difference in delta N15 was found between suspended and bottom sediments. With nitrogen isotopic differences between water-column seston and surficial sediments, it is estimated that 15-30% of planktonic production is deposited in the sediments during spring. If this organic matter is remineralized in late summer and fall, it could support up to 20% of primary production at that time. (Author's abstract)
W89-05803

ORGANIC MATTER SOURCES TO THE WATER COLUMN AND SURFICIAL SEDIMENTS OF A MARINE BAY,
Washington Univ., Seattle. School of Oceanography.
J. I. Hedges, W. A. Clark, and G. L. Cowie.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1116-1136, September 1988. 10 fig, 4 tab, 73 ref. NSF Grants OCE 82-19294 and OCE 84-21023.

Descriptors: *Organic matter, *Marine sediments, *Bays, *Carbon cycle, Sediments, Plankton, Sampling, Carbon, Organic carbon, Isotope studies, Nitrogen, Detritus, Vascular tissues.

Sediment trap and net plankton samples were collected monthly for a year at three depths in a marine bay (Dabob Bay, WA). These materials and subsamples from a sediment box core were analyzed for lignin oxidation products as well as elemental and stable carbon isotope compositions. Vascular plant debris accounted for 10% (nonwinter months) to 35% (winter months) of the total organic carbon in the upper water column (30 m) sediment trap samples and consisted predominantly of gymnosperm wood along with some nonwoody gymnosperm tissues and angiosperm woods. Bulk land-derived organic matter in Dabob Bay contained a maximum of 50% vascular plant debris and comprised an average of one-third of the total organic carbon in the sediment trap samples and two-thirds of the total organic carbon in the underlying sediments. Vascular plant debris introduced to the bay had already lost almost half of its initial bulk polysaccharide. Lignin and neutral sugars together accounted for < 20% of the total organic carbon in the sediment trap and core samples. Overall, the sediments of Dabob Bay compositionally resembled the gymnosperm wood-rich particulate material introduced to the overlying water column during winter and poorly recorded the input of plankton and other types of vascular plant debris during nonwinter months. (See also W89-05805) (Author's abstract)
W89-05804

FLUXES AND REACTIVITIES OF ORGANIC MATTER IN A COASTAL MARINE BAY,

Washington Univ., Seattle. School of Oceanography.
J. I. Hedges, W. A. Clark, and G. L. Cowie.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1137-1152, September 1988. 7 fig, 3 tab, 69 ref. NSF Grants OCE 82-19294 and OCE 84-21023.

Descriptors: *Cycling nutrients, *Organic matter, *Coastal waters, *Bays, *Marine environment, *Solute transport, Particulate matter, Environment, Carbon, Organic carbon, Nitrogen, Hydrocarbons, Sugars, Sediments, Advection, Organic compounds, Carbohydrates, Degradation, Plankton, Sediment-water interfaces, Phenols.

Vertical fluxes of bulk particulate material, organic carbon, nitrogen, lignin-derived phenols, and neutral sugars through the water column and into surface sediments of Dabob Bay, WA were determined monthly for 1 yr by sediment traps at three depths. Vertical fluxes of sinking bulk particulate material in this marine bay were elevated during winter and increased in consistent proportion to trap depth. The monthly fluxes of lignin-derived phenols paralleled those of total particulate material, indicating a common riverine origin. On average, 60 and 70%, respectively, of the total particulate organic carbon and nitrogen and 65-75% of all neutral sugars settling through the midwater column were deposited at the water-sediment interface. Land-derived organic material accounted for about one-third of the total organic carbon passing through the midwater column and two-thirds of the organic carbon accumulating in the underlying sediments. The amounts of plankton-derived organic matter sinking through the midwater column and being preserved in the sediments below corresponded to 14 and 3% of the annual mean primary productivity. Plankton-derived organic matter exhibited about 5 times the reactivity of local land-derived organic matter at the water-sediment interface of Dabob Bay and supported essentially all of the benthic respiration. (See also W89-05804) (Author'sract)
W89-05805

ROLE OF COMPLEXATION PROCESSES IN CADMIUM MOBILIZATION DURING ESTUARINE MIXING,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geochemistry.
For primary bibliographic entry see Field 5B.
W89-05813

IMPLICATIONS OF SEA-LEVEL RISE ON THE SOUTH SHORE OF LONG ISLAND, NEW YORK,
Maryland Univ., College Park. Dept. of Geography.
S. P. Leatherman.
Northeastern Environmental Science NOESDE, Vol. 7, No. 1, p 83-90, 1988. 8 fig, 17 ref.

Descriptors: *Sea level rise, *Long Island, *New York, *Seashores, Beach erosion, Saline water intrusion, Surface-groundwater relations, Storms, Management planning, Social aspects, Long-term changes, Flooding, Barrier islands.

The south shore of Long Island, New York, including the barrier islands and mainland fringe, is highly urbanized; these landforms are low-lying, making them particularly vulnerable to sea-level changes. The physical responses to higher sea levels include: (1) shoreline changes, resulting in increased beach erosion; (2) increases in storm flooding, converting 100-year storm surges into decadal events; and (3) groundwater changes, resulting from salt-water intrusion into coastal aquifers. All of the indicated changes will have a negative effect on the human habitation of this low-lying area. However, these impacts can be ameliorated or the changes accommodated once they are properly defined and understood. Response depends on local conditions and cost-benefit analysis. (Rochester-PTT)
W89-05833

LOCATION OF SEAGRASS BEDS IN ESTUARIES: EFFECTS ON ASSOCIATED FISH AND DECAPODS,
Fisheries Research Inst., Sydney (Australia).
J. D. Bell, A. S. Steffe, and M. Westoby.
Journal of Experimental Marine Biology and Ecology JEMBAM, Vol. 122, No. 2, p 127-146, October 18, 1988. 3 fig, 7 tab, 46 ref.

Descriptors: *Distribution patterns, *Estuaries, *Sea Grasses, Fish, *Crustaceans, *Fish populations, Aquatic ecosystems, Species composition, Species diversity, Population density, Juvenile growth stage, Environmental gradient, Estuarine environment, Larval growth stage, Seasonal distribution, Spatial distribution.

This study examined whether there were differences in abundance, species composition, and species richness of juvenile fish and decapods associated with Zostera capricorni. beds at different distances (zones) along an estuary were investigated in order to determine whether such variation was consistent between two arms of an estuary and if it occurred in different seasons. Total abundance of fish did not differ among zones or arms but abundance of decapods was often greatest near the mouth of each arm. More species of fish and decapods were caught in the lower and middle reaches of the estuary than in the upper reaches, although this depended on the arm. There were significant differences in abundances among zones for 13 of the 16 species studied separately in May, and for 17 of the 20 species examined in November/December. These differences were usually expressed as zone x arm interactions, and often occurred because individuals were absent or scare in one arm. Patterns of mean abundance among zones and arms were different for most species. Each combination of zone and arm had a distinct assemblage of fish and decapods. Artificial seagrass units (ASUs) were used to control for variation in physical complexity of Zostera among zones. There were striking similarities in patterns of abundance among zones and arms for the majority of species abundant enough for analysis in both Zostera and ASUs. The location of a seagrass bed within an estuary has a significant effect on abundances of juveniles of many species of fish and decapods. For most species, these effects are due to the position of the bed, not to its size, shape, leaf height or leaf density. The most likely cause of these effects is variation in distribution and availability of competent larvae. (Author's abstract)
W89-05866

PHAGE F2 DESORPTION FROM CLAY IN ESTUARINE WATER USING NONIONIC DETERGENTS, BEEF EXTRACT, AND CHAOTROPIC AGENTS,
Rhode Island Univ., Kingston. Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W89-05871

DEFINITION OF THE CONSISTENCY OF THE CARBON BUDGET OF AN ECOSYSTEM, AND ITS APPLICATION TO THE OOSTERSCHELDE ESTUARY, S.W. NETHERLANDS,
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
O. Klepper, and J. P. G. Van de Kamer.
Ecological Modelling ECMODT, Vol. 42, No. 3/4, p 217-232, September 1988. 4 fig, 3 tab, 18 ref.

Descriptors: *Carbon cycle, *Estuarine environment, *Netherlands, Linear programming, Mathematical analysis, Primary productivity, Mineralization, Detritus, Estimating, Uncertainty, Cycling nutrients.

Previous studies have produced estimates of the carbon flows that occurred in the Oosterschelde estuary before a storm-surge barrier was constructed in its mouth. Research is described that attempts to ascertain whether these estimates are consistent, i.e., whether balanced carbon budgets can be found for all the ecological groups investigated when each carbon flow is within the range of values obtained from laboratory of field data. In general, published carbon budgets either ignore errors or only adjust certain flows in an ad hoc fashion to obtain balanced budgets. A well-defined method of obtaining a balanced budget within the pre-specified ranges for the flows is presented. Starting from flow estimates with uncertainty ranges, an optimal balanced budget that minimizes the maximum (weighted) deviation between estimated and balanced flows is sought. Linear programming is required to achieve this. This set of flows and uncertainty estimates is defined as being consistent if the maximal deviation of the optimal solution lies within the uncertainty range of that estimate. The results obtained by following the above-mentioned procedure on a set of data collected in the Oosterschelde show that the maximum deviation of a carbon flow from its estimated value is 75% of its uncertainty range. The requirement that the carbon flows form balanced budgets and also fall within their uncertainty range results in marked reduction in the initial uncertainty range of primary production and detritus mineralization. Two possible extensions of the method are discussed that could make it applicable to data sets that are more detailed in space and/or time. (Author's abstract)
W89-05883

DISSOLVED IODINE BEHAVIOR IN ESTUARIES ALONG THE EAST COAST OF THE UNITED STATES,
Delaware Univ., Lewes. Coll. of Marine Studies.
For primary bibliographic entry see Field 2K.
W89-05906

DYNAMICS OF CARBON, NITROGEN, AND PHOSPHORUS CYCLING IN A SAWGRASS TIDAL MARSH WITH SPECIAL REFERENCE TO THE ABOVEGROUND PRIMARY PRODUCTION,
Florida Agricultural and Mechanical Univ., Tallahassee. Div. of Agricultural Science.
Y. P. Hsieh.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 676-681, October-December 1988. 4 fig, 3 tab, 38 ref, append.

Descriptors: *Tidal marshes, *Cycling nutrients, *Marsh plants, *Primary productivity, Carbon, Nitrogen, Phosphorus, Sawgrass, Soil organic matter, Simulation, Detritus, Florida.

The litter-bag method was used to assess the disappearance rates of organic C, N, and P from the plant detritus of a sawgrass (Cladium jamaicense) tidal marsh in North Florida. A steady-state kinetic model was used to simulate the effects of C, N, and P cycling dynamics on the quantity and quality of soil organic matter in the marsh. Four basic parameters were required for the model: (i) net annual primary production of C, N, and P; (ii) soil organic C, N, and P in the biologically active layer; (iii) disappearance rate of dead standing crop, and (iv) disappearance rate of sawgrass C, N, and P from the litter-bag. The decomposition of C, N, and P can be described by a two-component model through which a labile fraction and a refractory fraction of the primary production are defined. The rate constants of the labile fraction are one to two orders of magnitude greater than those of the refractory fraction. Simulation study indicated that the time required for soil C, N, and P to reach the steady state were 30, 60, and 70 yr. The simulation also indicated that the C/N ratio of the soil organic matter changed most significantly in the first 10 yr of the marsh development, whereas the N/P ratio remained relatively the same during the same period. The C/N and N/P ratios and the mean fraction remaining of soil organic matter all approach their respective steady-state values of 23, 13, and 0.47. The observed C/N and N/P ratios of the soil organic matter were 21 and 13. The calculated labile fractions of the sawgrass were 0.34, 0.205, and 0.488 for organic C, N, and P. The mean retention time (MRT) of C, N, and P in the labile fraction was 8.5 months. The MRTs of the refractory fractions were 10, 29, and 33 yr fir C, N, and P. The bulk of the soil organic matter consists almost entirely of the refractory fraction of the primary production. According to the simulation, decomposition rate constants of plant detritus were

the most significant and sensitive parameters that determine the quantity and quality of the soil organic matter. The annual N and P cycling rates between the aboveground sawgrass and the soil were estimated to be 18.8 and 1.9 g/sq m, respectively. (Author's abstract)
W89-05940

PHENANTHRENE DEGRADATION BY ESTUARINE SURFACE MICROLAYER AND BULK WATER MICROBIAL POPULATIONS,
New Hampshire Univ., Durham. Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W89-05968

NUTRIENT LIMITATION OF NET PRIMARY PRODUCTION IN MARINE ECOSYSTEMS,
Cornell Univ., Ithaca, NY. Ecosystems Research Center.
R. W. Howarth.
Annual Review of Ecology ARECBC, Vol. 19, p 89-110, 1988. 3 fig, 2 tab, 84 ref. NSF Grant BSR-8717134, EPA Grant CR812685-01.

Descriptors: *Primary production, *Marine environment, *Cycling nutrients, *Limiting nutrients, *Reviews, Oligotrophy, Nitrogen, Phosphorus, Geochemistry, Nitrogen fixation, Estuaries.

This review emphasizes estuaries and coastal bays which are the marine ecosystems most affected by eutrophication. Nutrient limitation in oligotrophic oceanic waters are briefly considered for comparative purposes. A variety of lines of evidence lead to the conclusion that net primary productivity in many marine ecosystems is probably limited by nitrogen, but phosphorus may limit production in some ecosystems. Differences in nutrient limitation are the result of differences in the ratio of total nitrogen to total phosphorus in nutrient inputs to the system and differences in internal biogeochemical processes. These biogeochemical processes include nitrogen fixation and a variety of recycling processes. Given similar inputs of nitrogen and phosphorus to temperate-zone lakes and marine ecosystems, nitrogen limitation is more likely in the marine ecosystems since planktonic nitrogen fixation is much less likely to make up nitrogen deficits. The current understanding of nitrogen and phosphorus limitation in marine ecosystems is limited by the great complexities in biogeochemical cycling and by uncertainties in nutrient inputs to estuaries. Whole-ecosystem experiments and mesocosm experiments in a variety of types of marine ecosystems are the best approach. Given the tremendous cost of controlling nutrient inputs to estuaries, whole-ecosystem experiments are needed to gain better information on nutrient limitation. (Miller-PTT)
W89-05970

COMPARATIVE ECOLOGY OF TIDAL FRESHWATER AND SALT MARSHES,
Virginia Univ., Charlottesville. Dept. of Engineering Science and Systems.
W. E. Odum.
Annual Review of Ecology ARECBC, Vol. 19, p 147-176, 1988. 5 fig, 4 tab, 140 ref. NSF Grant DEB-8109674 and Virginia Sea Grant NA81AA-D-00025.

Descriptors: *Ecology, *Tidal marshes, *Salt marshes, *Species composition, *Marshes, *Wetlands, Salinity, Reviews, Species diversity, Species composition, Sulfur, Taxonomy, Comparison studies.

The modest amount of information concerning physical and biological aspects of tidal freshwater wetland systems is compared with the more substantial literature about salt marsh systems in order to answer several fundamental questions: (1) what are the community and ecosystem-level effects of greatly lowering concentrations of dissolved salts and sulfur while maintaining similar tidal amplitudes; (2) are there, as a result, significant differences in community structure; (3) do the same taxonomic groups function in the same way in tidal freshwater marshes and in salt marshes; and (4) are the basic ecological processes such as primary production and decomposition similar in the two environments. It is apparent that while the basic structure and processes are the same in the two environments, significant differences do exist in species numbers and composition and in the patterns, rates, and end products of many of the processes. For example, extreme difference in sulfur concentrations in the two types of wetlands influences the composition of the anaerobic microbial communities; along with fermentors, methanogens predominate on tidal freshwater and sulfur reducers in the salt marsh. Numbers of intertidal vascular plant species declined dramatically between tidal and freshwater and salt marshes. This decline was accompanied by a decrease in palatability, a possible greater investment in below ground production, and a prevalence of asexual reproduction. Taxonomic groups (such as vascular plants, reptiles, and amphibians) that have evolved primarily in terrestrial and freshwater habitats show a trend of declining species numbers from tidal freshwater to salt marshes, presumably because of osmotic difficulties with salt water. Salinity has been shown to play an important role in most of the differences between tidal freshwater and salt marshes. But in almost every case, there are other factors (sulfide, species area relationships) that operate in a synergistic fashion and cannot be dismissed. (Miller-PTT)
W89-05971

DENSITY AND BIOMASS OF PHYTOPLANKTON AND PICOPLANKTON FROM FERTILIZED FISH PONDS OF 'VALLE FOSSE' AND 'VALLE ZAPPA' (VENICE LAGOON - NORTH ITALY) (DENSITE ET BIOMASSE DU PHYTOPLANCTON ET DU PICOPLANCTON DANS DES BASSINS FERTILISES EN 'VALLE FOSSE' ET 'VALLE ZAPPA' (LAGUNE DE VENISE) (ENGLISH SUMMARY),
Padua Univ. (Italy). Dept. of Biology.
P. C. Andreoli, and C. Tolomio.
Archiv fuer Hydrobiologie, Supplement AHBSA8, Vol. 78, No. 4, p 505-528, September 1988. 12 fig, 7 tab, 12 ref.

Descriptors: *Species composition, *Aquaculture, *Fish farming, *Phytoplankton, *Biomass, *Nitrates, *Phosphates, *Lagoons, *Multivariate analysis, Picoplankton, Plankton blooms, Mathematical studies.

Quantitative and qualitative distribution and biomass of phytoplankton and picoplankton as related to the hydrographic conditions were studied during 1985, in some fertilized ponds of Venice lagoon used for Penaeus japonicus cultures. The biological as well as the physico-chemical properties of the outer lagoon environment were also surveyed. The multivariate analysis of the data stressed that there are not remarkable differences between the culture ponds and the outer lagoon environment. The abundance of nitrates and phosphates caused a high plankton growth, with frequent blooms of small flagellates and picoplankton, in both environments. (Author's abstract)
W89-05980

EXCHANGE PROCESSES IN ESTUARIES SUCH AS THE WESTERSCHELDE: AN OVERVIEW,
Nederlands Inst. voor Onderzoek der Zee, Texel.
For primary bibliographic entry see Field 5B.
W89-05981

SOIL ENVIRONMENT OF THE INTERTIDAL AREA IN THE WESTERSCHELDE,
Institute of Earth Sciences, Utrecht (Netherlands). Comparative Sedimentology Div.
O. Oenema, R. Steneker, and J. Reynders.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 21-30, 1988. 5 fig, 1 tab, 23 ref.

Descriptors: *Westerschelde, *The Netherlands, *Estuaries, *Geochemistry, *Biochemistry, *Heavy metals, *Soil environment, *Intertidal areas, *Soil contamination, Organic matter, Sulfides.

Some characteristic features, based on field studies in the Westerschelde estuary since 1984 and on experienced obtained elsewhere, of the soils of the intertidal area in the Westerschelde are discussed. The multifunctional character of the soil and its complexity are, to some degree, illustrated by the discussion about the effect of sedimentation processes and surface morphology on the soil. The semi-terrestrial soil of the intertidal area is a complex environment where hydrosphere, biosphere, lithosphere and atmosphere interact. Surface morphology and the semi-diurnal tide may significantly modify this interaction pattern. Organic matter and constituents of the clay-size fraction are the most reactive compounds in the soil. The pathway and rate of organic matter decomposition determined the nature of many biogeochemical processes. Sulfur transformations are dominant processes in the sulfidic grey-black colored horizons underneath the generally thin yellow-brown surface layer. The sulfur geochemistry also affects the sorption-behavior of metals. Oxygen intrusion by diffusion, burrowing fauna and plant roots cause a local and sometimes temporary oxidation of reduced organic compounds. Thus, in the surface layers, and in and around tubes and roots at greater depth in the soil, a dynamic cycling occurs of redox active compounds, which affects the sorption mechanism of metal ions. (Miller-PTT)
W89-05982

BIOTA AND ABIOTIC ENVIRONMENT IN THE WESTERSCHELDE ESTUARY,
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
C. Heip.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 31-34, 1988. 14 ref.

Descriptors: *The Netherlands, *Westerschelde, *Estuarine environment, *Biota, *Estuaries, *Sedimentation, *Plankton, *Benthos, Tidal mixing, Species diversity.

The chemical environment, biota and sedimentation were studied in the Westerschelde Estuary. An estuary such as the Westerschelde is a highly dynamic environment, both on an ecological time scale where climatic and hydrodynamic forces, mainly the tides, shape a very variable environment on a geological, evolutionary time scale, since estuaries are young and very unstable habitats. Low species diversity and high adaptability of the resident animal and plant populations are characteristic of estuarine habitats where large fluctuations in submersion, salinity, temperature, etc., occur. The existing biota are therefore resilient to environmental stress and effects of the important influx of inorganic and organic pollutants from the river Schelde and its tributaries on the biota in the estuary are not easy to detect. Although water movement and sedimentation patterns in the Westerschelde are relatively well known, there exists little information on important ecological processes such as primary production and heterotrophic metabolism in the estuary. (Author's abstract)
W89-05983

CONCOMITANT EXISTENCE OF A TYPICAL COASTAL AND A DETRITUS FOOD CHAIN IN THE WESTERSCHELDE ESTUARY,
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
H. Hummel, G. Moerland, and C. Bakker.
Hydrobiological Bulletin, Vol. 22, No. 1, p 35-41, 1988. 3 fig, 17 ref.

Descriptors: *Westerschelde, *The Netherlands, *Detritus, *Tidewater, *Food chains, *Brackish water, *Estuaries, *Estuarine environment, *Coastal waters, Flora, Fauna, Seasonal variation, Saltwater freswater-interfaces.

Although the aquatic ecology of the Westerschelde estuary have been erratic, the results of a literature research show that some structural aspects of the ecosystems in the Westerschelde could be derived. Clear gradients could be found from the river to the sea for the abiotic as well as for the biotic features of the estuary. On the basis of the

available quantitative data, 2 tentative food chains were distinguished: (1) a mainly detritus-based food chain in the upstream brackish part, and (2) a coastal food chain in the downstream seaward part. The center of the area of the detritus food chain coincided with the zone of a turbidity maximum at the interface of salt and fresh water. This food chain is characterized by a low primary production but a year-round high concentration of suspended organic matter. The suspended organic matter consists of aggregates of detritus and bacteria. The zooplankton and the zoobenthos can reach high biomasses. The coastal food chain is mainly based on a seasonally changing high primary production. The diversity of flora and fauna in this system is much higher than in the detritus food chain, although the biomass can be lower. (Author's abstract)
W89-05984

MODELLING MICROBIAL PROCESSES (PHYTO- AND BACTERIOPLANKTON) IN THE SCHELDE ESTUARY,
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
G. Billen, C. Lancelot, E. DeBecker, and P. Servais.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 43-55, 1988. 10 fig, 1 tab, 19 ref.

Descriptors: *The Netherlands, *Estuaries, *Model studies, *Phytoplankton, *Schelde, *Bacteria, Ecological models, Organic carbon, Nitrogen.

Models for the microbiological processes affecting biogenic substances in the Schelde estuary and its watershed have been studied over the past ten years. The first model, a one-dimensional redox model, simulated the longitudinal distribution of oxygen, nitrate, iron and manganese in relation to the observed bacterial heterotrophic activity. A model allowing calculation of bacterial activity from data on organic discharge was coupled to this model. It was completed by a model of phytoplanktonic development within the estuary. Finally, an idealized model of the hydrographical network, based on Horton analysis, is being established in order to calculate the quality of the water at the downward boundary of the estuary. Together, all these sub-models form a general model of the ecological working of the Schelde estuary, able to predict at least the general trends of the redox state, the organic carbon, mineral nitrogen, and chlorophyll-a concentrations as a function of distance to the sea, from the knowledge of geomorphological and meteorological data, along with information concerning the distribution of anthropogenic discharges. This model therefore provides a powerful tool for the rational management of the Schelde estuary. (Author's abstract)
W89-05985

SALT MARSHES OF THE WESTERSCHELDE AND THEIR ROLE IN THE ESTUARINE ECOSYSTEM,
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
A. H. L. Huiskes.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 57-63, 1988. 4 fig, 3 tab, 24 ref.

Descriptors: *The Netherlands, *Estuaries, *Salt marshes, *Carbon, *Nutrients, *Westerschelde, *Estuarine environment, Esosystems, Fluctuations, Detritus.

The possible role of the Westerschelde estuary as a carbon and mineral source is discussed. It is estimated that the total area of salt marsh adds about 8% to the organic matter input in the estuary while the nutrient input may be as high as 25%. Salt marshes are highly productive ecosystems. They are wetlands and all wetlands together account for 2.3% of the world's net productivity, although they occupy only 0.4% of the world's area. They equal in productivity the tropical rain forests. This yearly production dies off and is eventually washed out of the salt marsh into the estuary, deposited against the dikes or decomposed in the marsh itself. Litter within the marsh comes from various sources but about 80% of it originates from higher plants. It is shown that salt marshes may contribute in a minor way to the detritus pool in the estuary, but their role in the nutrient pool might be significant. (Miller-PTT)
W89-05986

PLANKTON COPEPODS TEMORA LONGICORNIS AND ACARTIA TONAS, AND THEIR FOOD IN THE OOSTERSCHELDE ESTUARY (S.W. NETHERLANDS),
Delta Inst. for Hydrobiological Research, Yerseke (Netherlands).
C. Bakker, M. L. M. Tackx, and P. Van Rijswijk.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 75-78, 1988. 4 fig, 1 tab, 7 ref.

Descriptors: *Species composition, *Plankton, *Copepods, *Phytoplankton, *Estuaries, *Food schelde habits, *Schelde, *The Netherlands, Seston, Acartia, Temora.

Some data in relation to seston characteristics of the Oosterschelde estuary are given. Calanoid copepods dominated by Temora longicornis and Acartia spp. represent 60-80% of total zooplankton biomass. Grazing of adult copepods was studied using the Coulter counter. Phytoplankton contribution to total seston volume was estimated microscopically. Development rate of larval stages of Temora was simulated from observed density and related to available food. Egg production of adult Temora females was estimated and related to temperature and food. In all experiments, Temora longicornis, a marine coastal copepod, ingested almost exclusively phytoplankton. Acartia tonsa, a truly estuarine copepod, tended to detritivorous feeding, because the animal appeared to switch more rapidly to smaller particles. In the near future, shifts may be expected in seston/phytoplankton relationships and in phytoplankton composition of the estuary, as a consequence of decreased current velocities and increased sedimentation in the eastern part, caused by the functioning of the storm-surge barrier. It is predicted that Acartia tonsa will show a competitive lead compared with other copepod species and respond positively on these changing food conditions because the species outcompeted other copepods in closed estuaries with abundant growth of smaller phytoplankton. (Miller-PTT)
W89-05987

SOURCES AND DISTRIBUTION OF HYDROCARBONS IN BRIDGEWATER BAY (SEVERN ESTUARY, U.K.) INTERTIDAL SURFACE SEDIMENTS,
Royal Holloway and Bedford New Coll., Egham (England). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-05990

TWO-DIMENSIONAL FOURTH-ORDER SIMULATION FOR SCALAR TRANSPORT IN ESTUARIES AND COASTAL SEAS,
Institut de Biogeochimie Marine, Paris (France).
For primary bibliographic entry see Field 5B.
W89-05991

DETERMINATION OF ESTUARINE DIFFUSION COEFFICIENTS USING A FLUOROMETRIC DYE TRACING TECHNIQUE,
Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.
I. Guymer, and J. R. West.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 8, No. 6, p 297-310, September 1988. 7 fig, 4 tab, 17 ref.

Descriptors: *Tracers, *Dye releases, *Fluorometry, *Diffusion coefficient, *Estuaries, Wales Coast, Mixing, Plumes, Tidal current, Tidal range, Field tests, Data interpretation, Advection, Estimating, Hydrodynamics.

A series of field experiments, performed in the Conwy estuary (North Wales) are described. The aim of these experiments was to estimate values of the transverse and vertical mixing coefficients and to compare these values to ones predicted by the presently available information. Improvements in the fluorometric-tracing technique, incorporating more detailed hydrodynamic data, faster fluorometer response time and better plume definition, have been shown to give better recovery ratios and, therefore, more reliable estimates of the mixing characteristics. For ebb-tide results, a Fickian analogy appears to give a reasonable approximation to the system as the recorded dye distributions appear close to a Gaussian form. An average value of 170 sq cm per s for the transverse-diffusion coefficient was obtained from the ebb-tide data and the results suggest that this coefficient increases with tidal range. For flood-tide results, dye distributions were close to a Gaussian form for distances up to and approximately 300 m from the source. At distances greater than 300 m from the source, the secondary flow effects lead to departures from Gaussian characteristics and individual inspection of the results is required. From the flood-tide results an average value of the transverse-mixing coefficient, involving effects of both diffusion processes and advection due to secondary flow, of 840 sq cm per s was estimated. Difficulties in obtaining a good vertical spatial definition of the dye plume on flood tides made estimates of the vertical mixing parameters unrealistic; however, values of the vertical diffusion coefficient for ebb tides varying between 6 and 21 sq cm per s were obtained. The results show that bed topography, such as sand banks, can affect both flood- and ebb-tide mixing processes. (Miller-PTT)
W89-05993

PHYTOPLANKTON DEATH AND NITRIFICATION AT LOW TEMPERATURES,
Centre de Recherche en Ecologie Marine et Aquaculture, Nieul sur Mer (France).
For primary bibliographic entry see Field 2H.
W89-05994

MODULATED MIXING AND FRONTOGENESIS IN SHALLOW SEAS AND ESTUARIES,
Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.
P. F. Linden, and J. E. Simpson.
Continental Shelf Research CSHRDZ, Vol. 8, No. 10, p 1101-1127, October 1988. 13 fig, 1 tab, 15 ref.

Descriptors: *Density currents, *Mixing, *Estuaries, *Shallow water, *Frontogenesis, Barocline, Seawater, Turbulence, Density stratification, Tidal effects, Tidal currents.

Some laboratory experiments are described on the circulation produced in a fluid containing a horizontal density gradient in the presence of environmental turbulence whose level varies periodically with time. The experiments were intended to model the effects of turbulence generated by tidal flow in a shallow sea or estuary. At times of high tidal flow, the water column is vertically mixed and the baroclinically driven circulation is weak. At low turbulence levels, the baroclinic circulation accelerates and the water column stratifies. The longitudinal flux of density is measured and an effective longitudinal dispersion coefficient is calculated. The value of this coefficient increases with the horizontal density gradient and also with the period of the turbulence modulation. This latter increase is a result of the enhanced flux driven by the baroclinic circulation at low turbulence levels. The results of these experiments are compared with some recent measurements of episodic mixing events in Liverpool Bay (U.K.), Spencer Gulf (South Australia), and the Columbia River Estuary (U.S.). The time-dependent effect produced by a tidal flow is emphasized. The results show that it can be misleading to consider tidally averaged quantities in these situations, and much of the physics is excluded when variations during a tidal cycle are excluded. (Author's abstract)
W89-05995

ABUNDANCE AND CELLULAR CHARACTERISTICS OF MARINE SYNECHOCOCCUS SPP. IN THE DILUTION ZONE OF THE CHANGJIANG (YANGTZE RIVER, CHINA),

Centre d'Etudes d'Oceanographie et de Biologie Marine, Roscoff (France).
D. Vaulot, and N. Xiuren.
Continental Shelf Research CSHRDZ, Vol. 8, No. 10, p 1171-1186, October 1988. 12 fig, 27 ref.

Descriptors: *Population density, *Plant morphology, *Cyanophyta, *Saline-freshwater interfaces, *China, *Yangtze River, Microscopy, Cell size, Environmental gradient, Euphotic zone, Thermocline, Population dynamics.

Concentrations of the marine cyanobacterium Synechococcus were estimated in the dilution zone of the Changjiang (Yangtze River, China) using epifluorescence microscopy while cell size and photosynthetic pigment content were measured with flow cytometry. Cyanobacteria concentrations (100 to 1000 cells/ml in winter, 100 to 100,000 cells/ml in summer) increased in the offshore direction and reached their maximum at the most marine stations in winter and at stations of intermediate salinities (25 to 30 g per l) in summer. In the latter season, concentrations in excess of 10,000 cell/ml developed in the surface layer when the euphotic depth increased beyond 10 m as a result of suspended matter sedimentation. Cell concentrations fell by an order of magnitude below the thermocline in comparison to the surface layer and the highest values were associated with the saline waters of the Taiwan Current. In summer, Synechococcus cell size (as measured by light scattered at 90 degree angle) was the smallest in the region of maximum cell concentration, probably in relation to the high population growth rate there. Cell phycoerythrin content (measured by fluorescence) was related to light availability and to a lesser extent to inorganic nitrogen concentration. (Author's abstract)
W89-05996

FIELD AND EXPERIMENTAL STUDY OF THE BIOACCUMULATION OF SOME TRACE METALS IN A COASTAL FOOD CHAIN: SESTON, OYSTER (CRASSOSTREA GIGAS), DRILL (OCENEBRA ERINACEA),
Nantes Univ. (France). Centre de Dosage des Elements Traces.
For primary bibliographic entry see Field 5B.
W89-06015

TRANSFER OF HEAVY METALS FROM SUSPENDED SEDIMENTS TO THE ALGA STICHOCOCCUS BACILLARIS IN AN ESTUARINE WATER MEDIUM,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
For primary bibliographic entry see Field 5B.
W89-06017

DOSE-RELATED TOXICITY OF COPPER AND CADMIUM IN STRIPED BASS LARVAE FROM THE CHESAPEAKE BAY: FIELD CONSIDERATIONS,
Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
For primary bibliographic entry see Field 5C.
W89-06018

REMOVAL OF HEAVY METALS FROM SEDIMENTS BY MANGROVES IN JIULONG ESTUARY, XIAMEN HARBOUR, CHINA,
Xiamen Univ. (China). Inst. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-06019

NATURAL TRACERS TO DETERMINE THE ORIGIN OF SEDIMENTS AND SUSPENDED MATTER FROM THE ELBE ESTUARY,
Institute for Soil Fertility, Haren (Netherlands).
For primary bibliographic entry see Field 2J.
W89-06024

SORPTION BEHAVIOUR OF WASTE-GENERATED TRACE METALS IN ESTUARINE WATERS,
Plymouth Polytechnic (England). Inst. of Marine Studies.
For primary bibliographic entry see Field 5B.
W89-06026

STUDY ON THE SEASONAL VARIATION OF SURFACE SEDIMENT COMPOSITION IN ESTUARIES,
Okayama Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W89-06027

MODIFIED TIDAL PRISM MODEL FOR WATER QUALITY IN SMALL COASTAL EMBAYMENTS,
Virginia Inst. of Marine Science, Gloucester Point.
A. Y. Kuo, and B. J. Neilson.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 133-142, 1988. 6 fig, 4 ref.

Descriptors: *Model studies, *Hydrologic models, *Tidal prism, *Water quality, *Estuaries, *Path of pollutants, *Fate of pollutants, Tidal rivers, Mathematical models, Saline-freshwater interfaces, Tidewater, Simulation, Bays, Tides.

Simulation of physical transport processes in estuaries was based on Ketchum's tidal prism theory, modified and expanded such that it becomes applicable to cases where the embayment is branched and/or freshwater discharge is negligibly small. A model coastal embayment was divided into segments of lengths equal to local tidal excursions. Instead of starting the segmentation from landward end with freshwater discharge and tidal prism as two non-zero parameters, the modified model subdivides the water body starting from the seaward end with the difference between tidal prism and freshwater discharge as a single parameter. The mass balance within each segment was formulated by considering the exchange of water with its neighboring segments due to the flushing of freshwater discharge, as well as the tidal prism on ebb cycle, and to the mixing of the tidal prism on flood tide. This results in an algebraic equation which may be solved for concentration in each segment by successive substitution. For a nonconservative substance, the biochemical reaction terms may be easily added to the algebraic equation without complicating the solution scheme. The model has been applied to a number of tidal creeks and coastal embayments in Virginia. The application to the Lynnhaven Bay is presented. (Author's abstract)
W89-06028

RESUSPENSION OF SEDIMENTS FROM LONG ISLAND SOUND (U.S.A.),
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
For primary bibliographic entry see Field 2J.
W89-06030

EFFECT OF SALINITY ON NITRIFICATION IN A TIDAL RIVER,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W89-06031

EFFECTS OF SEWAGE SLUDGE DISPOSAL TO SEA - THE OUTER THAMES ESTUARY, U.K.,
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5C.
W89-06033

TWELVE YEARS OF OBSERVATIONS OF MERCURY CONCENTRATIONS IN YATSUSHIRO SEA (JAPAN),
Nagasaki Univ. (Japan). Faculty of Fisheries.
For primary bibliographic entry see Field 5B.
W89-06034

STUDY ON TRANSPORT AND MATERIAL BALANCE OF NUTRIENTS IN YAMAGUCHI ESTUARY (JAPAN),
Yamaguchi Univ. (Japan). Dept. of Civil Engineering.
M. Ukita, H. Nakanishi, and M. Sekine.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 199-210, 1988. 13 fig, 13 tab, 10 ref.

Descriptors: *Solute transport, *Nutrients, *Estuarine environment, *Estuaries, *Cycling nutrients, *Japan, Marsh management, Ecosystems, Water quality, Tidal marshes, Model studies, Pollution load, Suspended solids.

The transport and material balance of nutrients in the Yamaguchi Estuary were studied using environmental impact assessment (EIA), in order to investigate the effects of the reclamation of tidal marshes. The main methods utilized were: (1) a topographical survey; (2) pollutant load analysis; (3) water sampling during one tidal cycle; (4) sediment quality analysis; (5) box model analysis of water quality; and (6) modeling of the ecological system including fish. The main results obtained were as follows: (1) after the reclamation of 348 ha, the volume of the estuary, tidal prism, and tidal marsh area decreased by 6.5%, 12%, and 11%, respectively; (2) pollutant loads have increased from 1.38 to 1.69 t/d for N and from 0.09 to 0.18 t/d for P; (3) upward transport of suspended solids (SS) was observed under fine weather conditions, especially in the summer; (4) sediments in marsh areas exhibited higher values of oxygen consumption rate and nutrient recycling rate; (5) the net settling velocity of SS in the river mouth area was 1 to 3 m/d; (6) most of the SS transported up the estuary seemed to be flocculent organic matter; (7) the results of the box ecosystem model simulation indicated that there will be a net input of fish from the open sea area. (Author's abstract)
W89-06035

SUSCEPTIBILITY OF U.S. ESTUARIES TO POLLUTION,
Delaware Univ., Newark. Coll. of Marine Studies.
For primary bibliographic entry see Field 5B.
W89-06036

EFFECTS OF DEVELOPMENT OF A TIDAL BARRAGE UPON THE WATER AND SEDIMENT QUALITY OF THE MERSEY ESTUARY (U.K.) AND ITS BIOTA,
RPS Environmental Services Ltd., Mold (Wales).
For primary bibliographic entry see Field 6G.
W89-06038

WATER QUALITY MANAGEMENT OF THE HOOGHLY ESTUARY - A LINEAR PROGRAMMING MODEL,
Calcutta Metropolitan Development Authority (India).
For primary bibliographic entry see Field 5G.
W89-06039

ROLE OF ESTUARINE MODELING IN NUTRIENT CONTROL,
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-06040

SOME STUDIES TO REDUCE SEDIMENTATION IN A PORT ON A TIDAL RIVER,
Hanover Univ. (Germany, F.R.). Franzius-Inst. fuer Wasserbau und Kuesteningenieurwesen.
For primary bibliographic entry see Field 2J.
W89-06041

DISPERSION MODELLING FOR A COMPLEX ESTUARY: THE CASE OF THE TAGUS,
Universidade Nova de Lisboa (Portugal). Environmental Systems Analysis Group.
For primary bibliographic entry see Field 5B.
W89-06043

ROLE OF MODELLING IN THE CONTROL OF SEAWATER POLLUTION,

Port and Harbour Research Inst., Yokosuka (Japan). Marine Hydrodynamics Div.
For primary bibliographic entry see Field 5G.
W89-06044

APPLICATION OF BASIN WIDE ECOLOGICAL MODELS (BAWEMS) TO THE FATE OF LAS IN TOKYO BAY,
Osaka Univ. (Japan). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-06045

BIOLOGICAL INDICATORS AND BIOLOGICAL EFFECTS OF ESTUARINE/COASTAL POLLUTION,
National Marine Fisheries Service, Oxford, MD. Northeast Fisheries Center.
For primary bibliographic entry see Field 5A.
W89-06047

ABNORMALITIES AND DISEASES OBSERVED IN COMMERCIAL FISH CATCHES FROM BISCAYNE BAY, FLORIDA,
For primary bibliographic entry see Field 5C.
W89-06050

DETERMINING THE RELATIONSHIP BETWEEN WATER QUALITY AND INFECTIOUS DISEASE IN FISHERY POPULATIONS,
North Carolina State Univ. at Raleigh. Coll. of Veterinary Medicine.
For primary bibliographic entry see Field 5C.
W89-06051

EFFECT OF BIOLOGICAL VARIABILITY ON MONITORING STRATEGIES: METALLOTHIONEINS AS AN EXAMPLE,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 5A.
W89-06053

CORRELATION OF COPROSTANOL TO ORGANIC CONTAMINANTS IN COASTAL AND ESTUARINE SEDIMENTS OF THE U.S.,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
For primary bibliographic entry see Field 5B.
W89-06054

RELATIONSHIP OF SMOOTH CORDGRASS (SPARTINA ALTERNIFLORA) TO TIDAL DATUMS: A REVIEW,
Louisiana State Univ., Baton Rouge. Lab. for Wetland Soils and Sediments.
K. L. McKee, and W. H. Patrick.
Estuaries ESTUDO, Vol. 11, No. 3, p 143-151, September 1988. 5 fig, 3 tab, 57 ref.

Descriptors: *Spartina, *Tidal amplitude, *Marsh plants, *Coastal marshes, Reviews, Atlantic coast, Gulf coast, Intertidal zone, Aquatic plants, Marshes, Wetlands, Statistical analysis, Vertical distribution, Ecology, Salinity, Nutrients.

An analysis of data relating Spartina alterniflora to tidal elevations along the Atlantic and Gulf coasts demonstrated that although this species is primarily confined to the intertidal zone, its elevational limits of occurrence do not correspond to a consistent elevation relative to a tidal datum in all marsh locations. The variation in the vertical distribution of this species reported among marsh studies was attributed primarily to differences in mean tide range (MTR). A positive correlation between MTR and elevational growth range ($r = 0.91$) demonstrated that the Spartina alterniflora zone expands with increasing tidal amplitude. Differences in MTR among marsh locations accounted for 70 and 68% of the statistical variation in the upper and lower limits, respectively, of S. alterniflora growth. Among marshes of similar tidal amplitudes, the upper limit of occurrence of S. alterniflora in northern marshes was significantly lower than that in marshes at lower latitudes. These results, in combination with regional differences in plant species distribution across the upper intertidal zone, suggested that some of the variation in the upper limit was due to latitudinal differences in growth conditions and/or differences in interspecific competition. Local and regional differences in other factors such as salinity, nutrients, or physical disturbance may also have contributed to the variation in the limits of growth relative to a tidal plane within and among marshes. (Author's abstract)
W89-06093

ROLE OF TIDES IN REDISTRIBUTING MACRODETRITAL AGGREGATES WITHIN THE SWARTVLEI ESTUARY,
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
A. K. Whitfield.
Estuaries ESTUDO, Vol. 11, No. 3, p 152-159, September 1988. 6 fig, 2 tab, 21 ref.

Descriptors: *Tides, *Detritus, *Estuaries, *Aquatic plants, Distribution, South Africa, Algae, Macrophytes, Biomass, Sedimentation, Spring tides, Neap tides, Tidal prism, Shores, Zostera.

The Swartvlei estuary (South Africa) possesses a prolific growth of both intertidal and subtidal eelgrass, Zostera capensis. During 1984, less than 12% of the eelgrass beds were located in the upper half of the estuary, yet deposition of Zostera/macroalgal wrack in this region, when the estuary was linked to the sea (open phase), was similar to that in the lower half. Over a period of 20 semidiurnal tidal cycles, there was a net gain of 2.5 tons dry mass of plant material into the upper reaches. Export of aquatic macrophytes and filamentous algae from the lower reaches toward the sea over 20 tidal cycles amounted to 1.6 tons dry mass. The amount of plant material transported during spring tides was 2 to 3 times greater than that carried during neap tides. Shallowing of the estuary mouth due to sand deposition resulted in a decline in the tidal prism and a decrease in macrodetrital flux. Total export of Zostera and associated algae amounted to 0.87 g ash-free dry mass/sq m/d and represented a monthly export of 18% of Zostera bed biomass. Deposition of plant wrack during the 1984-1985 closed phase amounted to 63 g dry mass per meter of shore per day at the lower reaches site but only 10 g/m/d was recorded at the upper reaches site. The relatively low latter value was attributed to the absence of tidal action which transports macrodetritus from the lower and middle reaches into the upper part of the system. During the 1984 open phase, 70 g/m/d was deposited at the lower reaches site and 68 g/m/d at the upper reaches site. The role of tides in the redistribution of aquatic macrophyte primary production in the Swartvlei estuary was therefore clearly underscored. (Author's abstract)
W89-06094

FISH COMMUNITY OF THE SWARTVLEI ESTUARY AND THE INFLUENCE OF FOOD AVAILABILITY ON RESOURCE UTILIZATION,
Rhodes Univ., Grahamstown (South Africa). Inst. of Freshwater Studies.
A. K. Whitfield.
Estuaries ESTUDO, Vol. 11, No. 3, p 160-170, September 1988. 3 fig, 8 tab, 40 ref.

Descriptors: *Estuaries, *Fish diets, *Fish food organisms, *Food chains, *Estuarine environment, South Africa, Fish, Ecology, Biomass, Statistical analysis, Algae, Diatoms, Aquatic life, Aquatic plants, Aquatic animals, Benthos, Foods, Invertebrates, Tides, Leaves.

Structural and functional characteristics of the Swartvlei estuary (South Africa) fish community are described. The detritivore group of fishes comprised 49% of the total catch biomass, zoobenthivores 25%, herbivores 18%, piscivores 6%, and epifauna/zooplanktivores 2%. The diets of 18 fish species, based on the analysis of 1,648 stomach contents, are presented. Selection by Swartvlei estuary fishes for zoobenthic invertebrates and aquatic macrophytes in different habitats was calculated using the linear index of selection. Results indicated a strong positive selection for epifaunal invertebrates and poor utilization of infauna and plants. Plant consumption by herbivorous fishes in the estuary centered around filamentous algae and diatoms growing on Zostera capensis, rather than seagrass leaf material. The detrital base for both eelgrass and sand-dominated areas in the Swartvlei estuary is emphasized, and most of the fish biomass was supported directly or indirectly by detritus. Large catches (mass per unit effort) in the macrophyte-free upper reaches site were attributed to the tidal input of Zostera leaves and associated algae to the area and its subsequent utilization by fishes through the detrital food chain. (Author's abstract)
W89-06095

NOAA GULF OF MEXICO STATUS AND TRENDS PROGRAM: TRACE ORGANIC CONTAMINANT DISTRIBUTION IN SEDIMENTS AND OYSTERS,
Texas A and M Univ., College Station. Dept. of Oceanography.
For primary bibliographic entry see Field 5B.
W89-06096

LABORATORY STUDIES ON EELGRASS SEED AND SEEDLING PREDATION,
Adelphi Univ., Garden City, NY. Dept. of Biology.
C. Wigand, and A. C. Churchill.
Estuaries ESTUDO, Vol. 11, No. 3, p 180-183, September 1988. 1 fig, 2 tab, 9 ref.

Descriptors: *Estuarine environment, *Aquatic plants, *Predation, *Seedlings, *Seeds, *Foods, Crustaceans, Mollusks, Fish, Invertebrates, Snails, Crabs, Ecology, Bays, Eelgrass.

Ten species, including crustaceans, mollusks, and fish, were examined for predacious activity on Zostera marina seeds and seedlings. Predation was examined initially by offering seeds or seedlings as a sole food source for a maximum period of one week. Species exhibiting predation of 10% or more of the seeds or seedlings were tested further with bits of clam or scallop as an alternative food source. In these experiments, animals were tested in each of three conditions: (1) alternative food plus seeds or seedlings; (2) alternative food alone; (3) seeds or seedlings alone. In the initial experiments, Ovalipes ocellatus, Pagurus longicarpus, and Panopeus herbstii preyed on seeds, and Ilyanassa obsoleta, Littorina littorea, and P. longicarpus preyed on seedlings. Limited predation occurred, however, when these animals were presented with seeds or seedlings plus an alternative food. These data suggest that several common crab and snail inhabitants of eelgrass meadows are capable of preying on eelgrass seeds and seedlings, but that this activity may be influenced by the availability of an alternative food source. (Author's abstract)
W89-06097

CHANGES IN SEASONAL WATER TRANSPORT IN A LOUISIANA ESTUARY, FOURLEAGUE BAY, LOUISIANA,
Coastal Engineering Research Center, Vicksburg, MS.
T. A. Denes, and J. M. Caffrey.
Estuaries ESTUDO, Vol. 11, No. 3, p 184-191, September 1988. 4 fig, 3 tab, 34 ref.

Descriptors: *Water circulation, *Water transport, *Fourleague Bay, *Louisiana, *Estuaries, *Seasonal variation, *River flow, Bays, Atchafalaya River, Weather, Flow, Wind, Hydraulics, Water level, Marshes, Sedimentation, Tides, Nutrients, Sediment transport, Plankton.

Water transport in Fourleague Bay is strongly influenced by the discharge of the Atchafalaya River and prevailing wind conditions. In three 50-h intensive surveys, transport through the major inlets of the bay during the three major river discharge/weather regimes of the year was measured: strong frontal passage, high river flow, and calm, low river flow. Wind stress caused significant changes in both transport and water levels. North winds, dominant during winter frontal pas-

sages, caused a net export of water. During the high river flow survey, southeasterly winds created an opposing hydraulic pressure gradient in the Gulf of Mexico, diverting river flow into Fourleague Bay. This resulted in an increase in water elevation and the inundation of adjacent marshes. It is believed that this high-discharge, southerly wind condition is the major mechanism leading to sheet flow and sedimentation on the marsh. Calm, low-discharge conditions, typical of late summer, produced classic tidally-dominated circulation. (Author's abstract)
W89-06098

ESTUARINE MACROBENTHOS IN CALCASIEU LAKE, LOUISIANA: COMMUNITY AND TROPHIC STRUCTURE,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston, D.-L. Lee, and J. C. Nasci.
Estuaries ESTUDO, Vol. 11, No. 3, p 192-200, September 1988. 4 fig, 5 tab, 43 ref. DOE Grant DE-F601-83EP-31111.

Descriptors: *Species distribution, Estuarine environment, *Calcasieu Lake, Louisiana, *Estuaries, *Benthos, *Trophic level, *Food chains, Spatial distribution, Temporal distribution, Sampling, Polychaetes, Annelids, Oligochaetes, Amphipods, Crustaceans, Salinity, Sediments, Ecology.

Macrobenthic assemblages in Calcasieu Lake estuary were sampled at 11 sites from October 1983 through November 1985. The sites were numerically dominated by subsurface-deposit feeders, consisting mostly of polychaetes. Greater densities of macrofauna were collected at the northern (upper) stations of the lake than were collected in West Cove or the southern stations. Abundances of polychaetes, oligochaetes, and amphipods at the upper lake stations accounted for most of the differences among stations. The numerical dominance by detritivores (97% of the fauna) and lack of strong sediment or salinity gradients across the estuary resulted in an absence of temporal pattern in trophic structure of the macrofauna. The general lack of carnivores among the macrobenthos may be related to sediment variables. In fine-sediment habitats, such as those of Calcasieu Lake, limited pore space probably precludes the existence of interstitial predator and prey species. No interstitial spaces were found in abundance during the study. It is concluded that proportions of trophic groups may be fairly constant regardless of species dominance and abundance. Although the reasons for dominance by a single trophic group are not completely clear, these data provide a basis for generating future hypotheses to test ecosystem relationships in Calcasieu Lake. (See also W89-06100) (Author's abstract)
W89-06099

TROPHIC STRUCTURE OF MACROBENTHIC COMMUNITIES IN THE CALCASIEU ESTUARY, LOUISIANA,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston, and J. C. Nasci.
Estuaries ESTUDO, Vol. 11, No. 3, p 201-211, September 1988. 3 fig, 5 tab, 37 ref. DOE Grant DE-F601-83EP31111.

Descriptors: *Species composition, *Estuarine environment, *Trophic level, *Food chains, *Benthos, *Calcasieu Estuary, *Louisiana, Estuaries, Ecology, Temporal distribution, Foods, Salinity, Chemical properties, Dissolved oxygen, Mollusks, Crustaceans, Annelids.

Trophic groups were used to investigate broad patterns and predict species interactions of macrobenthic assemblages in Calcasieu Estuary, Louisiana. Macrobenthic assemblages of the estuary were numerically dominated by deposit-feeding species. Surface-deposit feeders were the most abundant macrobenthos of the upper estuary, subsurface-deposit feeders dominated the lower estuary, and a trophically well-mixed assemblage inhabited the middle estuary. There were periodic shifts in species dominance within each region, but the shifts were without temporal pattern and seldom led to changes in trophic structure of the region. The macrobenthic assemblages of the upper estuary were dominated by several early-colonizing species which switched feeding modes with changes in water flow, suggesting that disturbances in the upper estuary had a direct effect on macrobenthic communities. Disturbances also may have eliminated macrobenthic species before they could establish a well-mixed community. The presence of trophically mixed communities in the middle estuary probably was indicative of fewer disturbances there. The dominance by subsurface-deposit feeders in the lower estuary probably indicates that sedimentary food in Calcasieu Lake was seldom utilized at the sediment-water interface. Rather, most food became buried and was available only to subsurface-deposit feeders. (See also W89-06099) (Author's abstract)
W89-06100

CHEMISTRY OF OFF-FLAVOURS IN MARINE ORGANISMS,
Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Food Research.
For primary bibliographic entry see Field 5B.
W89-06110

MANGROVE AND SEAGRASS BEDS OF EAST ASIA: HABITATS UNDER STRESS,
Philippines Univ., Diliman, Quezon City. Marine Science Inst.
For primary bibliographic entry see Field 6G.
W89-06172

SEAWEED FLORA OF A YOUNG SEMI-ENCLOSED SEA: THE BALTIC SALINITY AS A POSSIBLE AGENT OF FLORA DIVERGENCE,
Liverpool Univ. (England). Dept. of Botany.
G. Russell.
Helgolaender Meeresuntersuchungen HEMEDC, Vol. 42, No. 2, p 243-250, 1988. 3 fig, 1 tab, 28 ref.

Descriptors: *Salinity, *Algae, *Baltic Sea, *Salt tolerance, Species diversity, Fucus, Photosynthesis, Species composition, Ecological effects, Resistance.

The salinity tolerances of Baltic and Atlantic populations of Fucus vesiculosus and Chorda filum have been measured using net photosynthesis as an index of tissue damage. Atlantic Fucus proved to have a broader salinity tolerance than Atlantic Chorda, a result which is consistent with others published on the tolerances of intertidal and sublittoral marine species. The optimum salinity for all Atlantic plants was 11 or 34 o/oo, but that of all Baltic plants was 6 o/oo. Baltic Fucus and Chorda were different in breadth of tolerance, in spite of the fact that they inhabit the same sublittoral habitat. This difference is interpreted in relation to their respective life-forms, Fucus being perennial and Chorda annual. Fucus is therefore present as a macrothallus at all times of year, including the critical low-salinity period of the spring ice-melt. Chorda evades damage by existing as a resistant microthallus at this time. It is concluded that the distinctive character of Baltic marine algae deserves nomenclatural recognition at some level below that of the species. The rank of subspecies would appear the most appropriate of those listed in the Code, but none of those available is able adequately to express the patterns of variation now being reported. (Author's abstract)
W89-06178

CYCLE OF EARTHQUAKE-INDUCED AGGRADATION AND RELATED TIDAL CHANNEL SHIFTING, UPPER TURNAGAIN ARM, ALASKA, USA,
Geological Survey, Anchorage, AK.
For primary bibliographic entry see Field 2J.
W89-06198

DISTRIBUTION OF ZOSTERA MARINA L. AND RUPPIA MARITIMA L. SENSU LATO ALONG DEPTH GRADIENTS IN THE LOWER CHESAPEAKE BAY, U.S.A.,
Virginia Inst. of Marine Science, Gloucester Point.
R. J. Orth, and K. A. Moore.
Aquatic Botany AQBODS, Vol. 32, No. 3, p 291-305, November 1988. 2 tab, 3 fig, 31 ref. EPA Grant R805951.

Descriptors: *Aquatic plants, *Macrophytes, *Plant populations, *Vegetation, Spatial distribution, Distribution, Water depth, Zostera marina, Ruppia maritima, Chesapeake Bay, Coastal waters, Bays.

Seventeen transects in areas containing beds of submerged aquatic vegetation in the lower Chesapeake Bay were selected for analysis of the depth distribution of R. maritima and Z. marina during a 6-week period (25 July-12 September 1987). Transects studied ranged in length from 130 to 1100 m with estimates of percent cover made on 785 plots. Mean importance value (relative frequency + relative cover) for Z. marina was 96.0 (range of 0-200) while for R. maritima it was 94.9 (0-184.4). Comparison of individual transects showed a consistent pattern of zonation where R. maritima occupied the nearshore, shallower area which graded to a mixed zone of R. maritima and Z. marina at intermediate depths. At the deepest part of the beds, Z. marina was the only species found. Transects along the western shore sites were characterized by lower percent cover with more open areas in the beds when compared with the eastern shore sites. The greater depth penetration of the two species along the eastern shore transect sites may reflect a greater influence of clearer, oceanic water compared with the more turbid, riverine influence along the western shore sites. The results demonstrate that both optimum and maximum depth limits for a species can vary considerably within a particular region and suggest the potential for marked variability over time. (Author's abstract)
W89-06253

EXTENT OF LATERAL WATER MOVEMENT IN THE SEDIMENTS OF A NEW ENGLAND SALT MARSH,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
W. K. Nuttle.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2077-2085, December 1988. 8 fig, 35 ref. NSF Grant BSR 8306433 and NOAA NA84AA-D-00046.

Descriptors: *Surface-groundwater relations, *Groundwater movement, *Salt marshes, *Coastal marshes, *Tidal marshes, *Marshes, Model studies, Hydrologic models, Sediments, Interstitial water, Hydraulic head models, Lateral water movement, New England, Hydraulic conductivity, Flooding.

Models of depth-averaged hydraulic head were used with data from a water balance study in a New England salt marsh to describe horizontal pore water water fluxes near a creek bank. Three hydrologically distinct regions are identified in the sediment. In the marsh studied, semidiurnal tides may drive an oscillating horizontal flux in the narrow region within about 2.5 m of the creek bank. Farther than 15 m from the creek there is essentially no horizontal water movement. In the region between 2.5 m and 15 m, drainage to the creek is driven by alternating periods of surface flooding and nonflooding due to the spring neap variation in tidal amplitudes. There is little or no input of fresh groundwater to the marsh sediment at this site. The spatial extent of the drained region depends on the duration of the nonflooded period, the morphology of the sediment surface, and the ratio of hydraulic conductivity to specific storage of the sediment. (Author's abstract)
W89-06262

SELENIUM ACCUMULATION IN BENTHIC BIVALVES AND FINE SEDIMENTS OF SAN FRANCISCO BAY, THE SACRAMENTO-SAN JOAQUIN DELTA, AND SELECTED TRIBUTARIES,
Geological Survey, Menlo Park, CA.
For primary bibliographic entry see Field 5B.
W89-06313

BENTHIC DIATOM BIOMASS, PRODUCTION AND SEDIMENT CHLOROPHYLL IN LANGEBAAN LAGOON, SOUTH AFRICA,
Cape Town Univ. (South Africa). Dept. of Zoology.
P. J. Fielding, K. S. J. Damstra, and G. M. Branch.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 27, No. 4, p 413-426, October 1988. 6 fig, 1 tab, 44 ref.

Descriptors: *Diatoms, *Chlorophyll a, *Marine algae, *Lagoons, *Marine sediments, *Primary productivity, Benthic flora, Chlorophyll, South Africa, Coastal waters, Biomass.

Direct measurements were made of the biomass of benthic diatoms in Langebaan lagoon, a sheltered lagoon on the west coast of South Africa. Highest biomasses occurred in the most sheltered areas and reached 18.9 g/sq m in the top 30 cm of sediment. A large biomass was found even at depths of 10-20 cm and 20-30 cm, often exceeding that in the 0-10 cm depth range. This contrasts with chlorophyll estimates of biomass, in which chlorophyll-a declines rapidly below the photic zone. Very high sediment turnover rates by benthic macrofauna account for the presence of microalgae at depths of 30 cm below the sediment surface. Currents or waves (and hence particle size) are inversely correlated with diatom biomass. Chlorophyll-a concentrations in the surface layers of the sediment may reach 322 micrograms Chl-a/g sediment, but generally values range from 0 to 34 micrograms Chl-a/g sediment. Like diatom biomass, chlorophyll-a concentration increases with declining waves and currents. The highest chlorophyll-a concentrations occur in the top 1 mm of sediment, declining to 35% of surface concentrations 5 cm below the surface. Rates of carbon fixation by benthic microalgae in the top 5 mm of sediment were 17.38 mg C/sq m/h at an exposed sandy beach, and 69.54 mg C/sq m/h at a sheltered sand/mud beach. Benthic microfloral production rivals phytoplankton production and ranges from estimates of 63 g C/sq m/year (sand) to 253 g C/sq m/year (sand/mud). In the lagoon ecosystem, production by benthic microalgae amounts to 22% of the total primary production of carbon. (Author's abstract)
W89-06315

BIOGEOCHEMICAL CONTROL OF THE SUMMER DISTRIBUTION AND SPECIATION OF ARSENIC IN THE TAMAR ESTUARY,
Southampton Univ. (England). Dept. of Chemistry.
For primary bibliographic entry see Field 5B.
W89-06316

EFFECTS OF SUBMERSED MACROPHYTES ON WATER QUALITY IN THE TIDAL POTOMAC RIVER, MARYLAND,
Geological Survey, Reston, VA.
V. Carter, J. W. Barko, G. L. Godshalk, and N. B. Rybicki.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 493-501, December 1988. 1 fig, 1 tab, 28 ref.

Descriptors: *Estuaries, *Submerged plants, *Macrophytes, *Aquatic vegetation, *Potomac River, *Water quality, *Tidal rivers, Chlorophyll a, Dissolved oxygen, Opacity, Environmental effects, River flow.

In August, 1986, diurnal measurements of temperature, conductivity, dissolved oxygen and pH, and tide-related measurements of suspended-particulate matter and chlorophyll-a were made at three stations within a dense macrophyte bed. Light penetration and current velocity were measured at a hole within the bed and at the unvegetated station. Water temperature, dissolved oxygen and pH increased during the day with the steepest vertical gradients and maximum readings occurring within the bed during midafternoon at low tide. Current velocities within the beds were about one-third of those at the open-water site and water clarity was considerably greater inside the bed. Chlorophyll-a and suspended-particulate concentrations were significantly lower at vegetated stations than at the unvegetated open-water station. (Author's abstract)
W89-06321

GENERATION AND DECAY OF HYDROGEN PEROXIDE IN ESTUARINE WATERS,
Australian Nuclear Science and Technology Organisation, Sutherland.
For primary bibliographic entry see Field 2K.
W89-06328

RESPONSE OF ARMERIA MARITIMA (MILL.) WILLD. AND PLANTAGO MARITIMA L. FROM AN IRISH SALT MARSH TO NITROGEN AND SALINITY,
Trinity Coll., Dublin (Ireland). School of Botany.
M. J. S. Skeffington, and D. W. Jeffrey.
New Phytology NEPHAV, Vol. 110, No. 3, p 399-408, November 1988. 6 fig, 2 tab, 31 ref.

Descriptors: *Nutrient requirements, *Coastal marshes, *Marsh plants, *Salt marshes, *Salinity, *Nitrogen, *Halophytes, *Vegetation, *Salt tolerance, Armeria, Plantago, Plant growth, Growth rates, Nutrients, Plant water potential.

Two experiments on the interaction between salinity and nitrogen supply were carried out on the halophytes Armeria maritima and Plantago maritima. Water potential values ranged from -0.16 MPa to -5.0 MPa and nitrogen from 0.28 to 280 mg/liter. An increase in nitrogen above 2.8 mg/liter nitrogen in the medium in all cases resulted in an increase in growth, though this was not as great at higher salinities. Armeria growth rate was optimal at a higher nitrogen concentration than Plantago. Armeria also accumulated nitrogen in shoots with increasing salinity. Plantago root nitrogen concentrations increased with increased nitrogen. Both species accumulated sodium in shoots, but in Armeria concentrations were lowest in the highest nitrogen treatments. Potassium was redistributed from shoots to roots with increasing salinity. Two populations of Plantago from the salt marsh were examined. Differences in growth response and flowering time were observed. A third, inland populatin of Plantago showed reduced vigor in water potential lower than -2.5 MPa. (Author's abstract)
W89-06334

OCCURRENCE AND DIET OF FISHES IN A TIDAL INLET TO A SALTMARSH IN SOUTHERN MORETON BAY, QUEENSLAND,
Queensland Dept. of Primary Industries, Brisbane (Australia). Fisheries Management Branch.
R. M. Morton, B. R. Pollock, and J. P. Beumer.
Australian Journal of Ecology AJECDQ, Vol. 12, No. 3, p 217-237, September 1988. 11 fig, 4 tab, 35 ref.

Descriptors: *Fish behavior, *Salt marshes, *Fish diets, *Fish management, *Inlets, *Tidal marshes, *Water management, Environmental protection, Australia.

The fishes occurring in the main tidal inlet to a typical saltmarsh situated in southern Moreton Bay were studied from January to December 1984. The type of fishes and their feeding habits within the inlet, particularly for species of economic importance. Sampling was conducted at night on the full and new moon phases, and during the day on the full moon phase. A total of 19 species were recorded from the inlet, of which 11 are of economic importance. Six species were considered common. Most fish that entered the inlet were juveniles. The diversity of the fish assemblage from the inlet was low when compared with findings of other studies conducted in Australian subtidal mangrove areas. Diel differences in the size of the fish entering the inlet were recorded for several species. Two mark-recapture programs were conducted to investigate short-term utilization fo the saltmarsh by fishes. Recapture rates indicated that individuals of some species regularly utilized the saltmarsh. The most abundant species from the inlet were predominantly benthic feeders although one species fed on plankton. Terrestrial foods formed an important part of the diet of some fishes. The inlet serves as a feeding area for certain species although it is unlikely that these species rely exclusively upon the area. Future management of saltmarsh areas should include protection and maintenance of tidal inlets wherever possible. (Author's abstract)
W89-06372

RECOLONIZATION OF SMALL DISTURBANCE PATCHES IN A NEW ENGLAND SALT MARSH,
Harvard Univ., Cambridge, MA. Dept. of Landscape Architecture.
J. M. Hartman.
American Journal of Botany, AJBOAA Vol. 75, No. 11, p 1625-1631, November 1988. 4 tab, 55 ref.
NSF Grants OCE 76-19278, DEB 81-04701, and OCE 82-14641.

Descriptors: *Salt marshes, *Vegetation regrowth, Recolonization, Vegetative expansion, New England, Seedlings, Salinity, Sulfides, Ammonia, Spartina.

Availability of colonizers and edaphic conditions were tested in relation to rates of recolonization of open patches in salt marsh vegetation. The density of buried viable seeds was estimated by counting seedlings in undisturbed vegetation and germinating seeds in the laboratory. A low density of viable seeds (<50/sq m) found in these salt marsh soils indicated the absence of an important viable seed bank in this system. Rates of recolonization in natural open patches were monitored for 3 years. Vegetative expansion of Spartina alterniflora, at approximately 12 cm/year, accounted for most of the recolonization of open patches, although some colonization of annual Salicornia spp. occurred from seeds. Salinity and sulfide and ammonium concentrations were measured in pore samples from depths of 2-7 cm and 10-15 cm of soil. Comparison of the concentrations from disturbed and undisturbed plots in the marsh did not show significant differences, indicating that none of the edaphic conditions measured would be more inhibitory to plant growth in the disturbed than the undisturbed plots. Therefore, the rate at which small open patches become recolonized is primarily controlled by proximity of Spartina alterniflora and its capacity for vegetative expansion. (Author's abstract)
W89-06374

CHRONIC TOXICITY OF TRIBUTYLTIN TO CHESAPEAKE BAY BIOTA,
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
For primary bibliographic entry see Field 5C.
W89-06393

ENVIRONMENTAL IMPACTS AND REGULATORY POLICY IMPLICATIONS OF SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 5E.
W89-06404

NARRAGANSETT BAY POLLUTION CONTROL: AN EVALUATION OF PROGRAM OUTCOME,
Rhode Island Univ., Kingston. Dept. of Marine Affairs.
For primary bibliographic entry see Field 5G.
W89-06405

INFLUENCE OF SUSPENDED PARTICULATE MATTER REGIME ON THE HEAVY METAL POLLUTION OF THE TIDAL RIVER ELBE AT HAMBURG,
Umweltbundesamt, Berlin (Germany, F.R.).
For primary bibliographic entry see Field 5B.
W89-06417

BELUGA WHALE ECOLOGY: A CONCERN OF FRESHWATER BIOLOGISTS,
Institute of Arctic Ecophysiology, Churchill (Manitoba).

P. D. Watts, and B. A. Draper.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 211-213, October, 1988. 1 fig, 1 tab, 9 ref.

Descriptors: *Estuarine environment, *Whales, *Hydroelectric plants, Manitoba, Saline-freshwater interfaces, Population density.

Churchill estuary beluga whales displayed their highest densities in freshwater habitat, suggesting preferential use. Whale densities in freshwater were as high as 350 animals/sq km and represented over one-tenth of the estimated Hudson Bay population. Future environmental assessments of hydroelectric development in northern Manitoba, Canada, must consider the effects on the beluga whales. (Author's abstract)
W89-06446

STUDIES OF A SUBARCTIC COASTAL MARSH: I. HYDROLOGY,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
J. S. Price, and M. K. Woo.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 275-292, November 30, 1988. 9 fig, 33 ref.

Descriptors: *Salt marshes, *Subarctic zone, *Snowmelt, *Coastal marshes, *Hydrologic budget, Hydrology, Evaporation, Peat, Water storage, Spatial distribution, Temporal distribution, Chlorides, Surface flow, Streamflow, Precipitation, Canada.

The hydrological processes of a subarctic coastal marsh undergoing rapid isostatic uplift were studied to assess the links between water inputs and outputs. A water balance was performed for the summer season. Precipitation was the major input, followed by surface inflow, but tidal inputs were unimportant. Streamflow and evaporation were major outputs, while surface flow losses were limited to the snowmelt period. Subsurface flows were insignificant. The water storage characteristics of the marsh regulated the flow processes and evaporation. Since they were strongly influenced by the uneven peat development and pronounced seasonality, water storage, and therefore the marsh hydrological system were highly variable in both time and space. (See also W89-06460) (Author's abstract)
W89-06459

STUDIES OF A SUBARCTIC COASTAL MARSH: II. SALINITY,
McMaster Univ., Hamilton (Ontario). Dept. of Geography.
J. S. Price, and M. K. Woo.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, p 293-307, November 30, 1988. 6 fig, 1 tab, 16 ref.

Descriptors: *Coastal marshes, *Salt marshes, *Salinity, *Mathematical models, Numerical analysis, Advection, Hydraulic gradient, Canada, Tidal marshes, Subarctic zone, Spatial distribution, Temporal distribution, Chlorides.

The salinity of James Bay coastal marshes is more strongly affected by fossil salt from the underlying sediments than from tidal sources. A numerical model simulates the transport of this salt towards the marsh surface by molecular diffusion. However, the more permeable sediments near the surface transmit salt by advection in the groundwater flow, notably at the beach ridges, where the vertical hydraulic gradients are the strongest. The diffusion and advection transport processes supply chloride, Cl(-), to the surface at rates of 0.4 and 6.0 g/sq m/day, respectively. Although the diffusion transport rate is low, this process contributed nearly half as much chloride to the marsh surface as advection did, because diffusion operates over a much larger area. These estimated chloride fluxes were within 15% of the measured average Cl(-) export in the stream channel which drains the marsh. A model simulating the daily rate of Cl(-) export indicates that its day to day variability is due to the near-surface hydrological processes, but over the long term is limited by the vertical advection and molecular diffusion processes that bring the salt to the surface. (See also W89-06459) (Author's abstract)
W89-06460

TWO-DIMENSIONAL FINITE ELEMENT MODEL FOR DISPERSION (2D-FED) IN COASTAL AQUIFERS,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-06509

TIDEPOOLS IN SOUTHERN RHODE ISLAND, U.S.A.: I. DISTRIBUTION AND SEASONALITY OF MACROALGAE,
Rhode Island Univ., Kingston. Dept. of Botany.
J. M. Wolfe, and M. M. Harlin.
Botanica Marina BOTNA7, Vol. 31, No. 6, p 525-536, November 1988. 5 fig, 4 tab, 55 ref.

Descriptors: *Tidepools, *Tidewater, *Rhode Island, *Seasonal variation, *Algae, *Species composition, *Ecology, *Marine biology, Distribution, Chlorophyta, Phaeophyta, Rhodophyta, Water temperature, Radiation.

Seasonality and distribution of macroalgae in eight Rhode Island tidepools were studied over a three-year period. Of the 35 taxa observed, 19 were found year-round. The highest number of total species (32) was found in June when spring and winter annuals overlapped, and the lowest number (20) appeared in October. Changes in percentage cover in most tidepool macroalgae were associated with changes in water temperature and incident radiation. In seven pools, the dominant species were Chondrus crispus and/or Hildenbrandia rubra. The dominant species in the highest pools were always green or brown algae. The greatest number of common species appeared in the most wave-exposed pools. The two pools with the highest littorine (Littorina littorea) densities supported the smallest number of common macroalgal species. Within each pool there appeared a marked seasonality of macroalgal communities. Seasonal changes in common species occurrence and abundance were similar to those previously reported for pools in northern New England, as was a conspicuous absence of a significant autumn flora, but macroalgal communities in this study demonstrated a greater seasonality. Rhode Island pools are thus both representative of other New England tidepools and unique in their own right. (See also W89-06531) (Author's abstract)
W89-06530

TIDEPOOLS IN SOUTHERN RHODE ISLAND, U.S.A.: II. SPECIES DIVERSITY AND SIMILARITY ANALYSIS OF MACROALGAL COMMUNITIES,
Rhode Island Univ., Kingston. Dept. of Botany.
J. M. Wolfe, and M. M. Harlin.
Botanica Marina BOTNA7, Vol. 31, No. 6, p 537-546, November 1988. 5 fig, 5 tab, 35 ref.

Descriptors: *Tidepools, *Tidewater, *Rhode Island, *Species diversity, *Algae, *Ecology, *Marine biology, Seasonal variation, Regression analysis, Gastropods, Chlorophyta, Phaeophyta, Rhodophyta.

Macroalgal communities from eight tidepools in southern Rhode Island and Massachusetts were compared to macroalgal communities described previously for pools in New Hampshire, Maine, and Ireland. Species diversity in the Rhode Island pools followed distinct seasonal patterns in which the highest pools showed greatest species diversity in late winter, preceding the maximum diversity for mid to low pools up to several months. Species diversity for Rhode Island pools was significantly associated with pool height, littorine density, volume, and surface area. Species diversity and littorine density were inversely related. Community similarity values calculated for these pools varied seasonally, with three types of seasonal patterns for two-pool combinations depending upon height and littorine density values. Dendrograms depicting community similarities in pools from Rhode Island, Massachusetts, Maine, and Ireland indicated three types of pools: (1) high green algal pools, (2) mid to low red-brown algal pools with high densities of littorines, and (3) mid to low red-brown algal pools with low densities of littorines. The fact that these three types of pools were found both on the western and eastern North Atlantic indicates that the composition of tidepool macroalgal communities is closely allied. Furthermore, there is a repeating sequence of tidepool macroalgal communities over time. (See also W89-06530) (Author's abstract)
W89-06531

PRODUCTION ECOLOGY OF EELGRASS (ZOSTERA MARINA L.) IN A CAPE COD SALT MARSH-ESTUARINE SYSTEM, MASSACHUSETTS,
Rutgers - The State Univ., New Brunswick, NJ. Center for Coastal and Environmental Studies.
C. T. Roman, and K. W. Able.
Aquatic Botany AQBODS, Vol. 32, No. 4, p 353-363, December 1988. 3 fig, 3 tab, 22 ref.

Descriptors: *Aquatic plants, *Productivity, *Cape Cod, Massachusetts, *Salt marshes, *Estuarine environment, Primary productivity, Leaves, Biomass, Seasonal variation, Ecology.

Primary production and biomass loss of Zostera marina were estimated at two sites within the Nauset Marsh system, Cape Cod, MA. Maximum live leaf-blade biomass at the Nauset Harbor (305 g dry weight (DW)/sq m) and Town Cove (199 g DW/sq m) sites peaked in mid-August. Maximum leaf-blade productivities, estimated by a leaf-marking technique, were 10.8 g DW/sq m/day and 5.5 g DW/sq m/day, respectively. Leaf-blade production occurred throughout the winter, but at much reduced rates (< 0.2 g DW/sq m/day, both sites). Net annual above-ground (leaf blades, reproductive shoots, sheaths) primary production was estimated at 987 g DW/sq m/year and 444 g DW/sq m/year, respectively. Peak rates of leaf-blade biomass loss occurred in early September (Nauset Harbor, 8.5 g DW/sq m/day; Town Cove, 4.7 g DW/sq m/day), corresponding to a period of high eelgrass-wrack accumulation on New England shorelines. Annual leaf-blade biomass loss was 577 g DW/sq m/year and 303 g DW/sq m/year, respectively. These loss rates, coupled with leaf-crop turnover rates of 6 crops/year, stress the role of eelgrass meadows in the support of estuarine detritus-based food webs. (Author's abstract)
W89-06533

ADSORPTION OF HUMIC SUBSTANCES ISOLATED FROM MARINE AND ESTUARINE SEDIMENTS,
Institut Rudjer Boskovic, Zagreb (Yugoslavia). Center for Marine Research.
For primary bibliographic entry see Field 2K.
W89-06544

SPECIATION OF METHYLTIN AND BUTYLTIN COMPOUNDS IN EELGRASS (ZOSTERA MARINA L.) LEAF TISSUE FROM THE GREAT BAY ESTUARY (NH),
New Hampshire Univ., Durham. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-06546

EFFECTS OF CHANGES IN SALINITY ON THE RATE OF PROTEIN SYNTHESIS IN THE TISSUE OF ESTUARINE MOLLUSCS NUTTALLIA OLIVACEA AND RUDITAPES PHILIPPINARUM (VLIYANIE IZMENENIYA SOLENOSTI SREDY NA SKOROST' SINTEZA BELKA V TKANYAKH ESTUARNYKH MOLLYUSKOV NUTTALLIA OLIVACEA I RUDITAPES PHILIPPINARUM),
Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.
L. A. Karpenko, A. D. Kharazova, and V. I. Fateeva.
Biologiia Moria BIMOD4, No. 6, p 64-67, 1987. 1 fig, 18 ref. English summary.

Descriptors: *Salinity, *Estuaries, *Mollusks, Proteins, Metabolism, Physical properties, Adaptation.

The effect of decreased (12%) and increased (48%) salinities on the rate of protein synthesis in different tissues of the estuarine bivalve mollusks Nuttallia olivacea and Ruditapes philippinarum was investigated. There were considerable changes in the rate of protein synthesis. A tissue specific reaction to salinity changes was revealed. Restoration of protein synthesis after inhibition was much less pronounced in R. philippinarum than in N. olivacea, which may be accounted for by the different mechanisms of adaptation to salinity changes in these mollusks. (Author's abstract)
W89-06554

STUDIES OF CARBON FLOWS IN MARINE ECOSYSTEMS USING NATURAL RATIOS OF STABLE ISOTOPES (IZUCHENIE POTOKOV UGLERODA V MORSKIKH EKOSISTEMAKH PO PRIRODNYM SOOTNOSHENIYAM STABIL'NYKH ISOTOPOV (13C/12C),
Akademiya Nauk SSSR, Vladivostok. Inst. Biologii Morya.
S. I. Kiyashko.
Biologiia Moria BIMOD4, No. 5, p 3-12, 1987. 2 fig, 68 ref. English summary.

Descriptors: *Food chains, *Estuaries, *Salt marshes, *Isotope studies, Organic carbon, Diets, Field tests, Sea grasses.

The sources and flows of organic carbon in food webs were investigated using the natural isotope label C13/C12 ratios. The method was used extensively to study the food webs of a number of marine ecosystems: seagrass beds, salt marshes, estuaries, and deep-sea hydrothermal vent communities. The method is also a useful tool for investigating the diet of different speicies of marine animals in the field. (Author's abstract)
W89-06556

SEASONAL AND ANNUAL RHYTHMS OF BACTERIAL NUMBERS IN THE AZOV SEA (SEZONNYE I GODOVYE RITMY SHISLENNOSTI BAKTERIAL'NOGO NASELENIYA AZOVSKOGO MORYA),
Azovskii Nauchno-Issledovatel'skii Inst. Rybnogo Khozyaistva, Rostov-na-Donu (USSR).
L. I. Tolokonnikova.
Biologiia Moria BIMOD4, No. 4, p 25-30, 1987. 2 fig, 19 ref. English summary.

Descriptors: *Environmental impact, *Azov Sea, *Bacteria, *Plankton, *Seasonal variation, *Industrial development, Microbiological studies, Quantitative analysis, Prediction, Water properties, Benthos.

Investigations of bacterioplankton and bacterial benthos of the Azov Sea during 1966-1982 revealed seasonal and annual variations in their numbers closely connected with changes in the hydrological regime and biological productivity of the sea. Quantitative relations of bacterial numbers and some biotic and abiotic factors make it possible to forecast changes in the microbiological regime of the Azov Sea in connection with different commercial activities. (Author's abstract)
W89-06557

POSSIBLE CHANGES IN THE ECOLOGICAL SYSTEM OF THE AZOV SEA THROUGH A NARROWING OF TAGANROG BAY (LOWER TROPHIC LEVEL)(VOSMOZHNYE PREOBRAZOVANIYA V EKOLOGICHESKOI SISTEME AZOVSKOGO MORYA PRI GIRLA TAGANROGSKOGO ZALIVA NIZHNIE TROFICHESKIE UROVNI),
Rostovskii-na-Donu Gosudarstvennyi Univ. (USSR).
V. G. Il'icev, and F. A. Surkov.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 16-22, 1987. 3 fig, 20 ref. English summary.

Descriptors: *Azov Sea, *Taganrog Bay, *Eutrophication, *Phytoplankton, *Morphology, *Deltas, Model studies, Productivity, Monitoring, Water quality.

A model was used to study changes in the phytoplankton-biogenous elements system in the Azov Sea with possible narrowing of the delta arm of the Taganrog Bay. It is shown that this design permits effective monitoring only of the Bay productivity. Considerable narrowing of the delta arm may result in eutrophication of the Taganrog Bay. (Author's abstract)
W89-06564

DISTRIBUTION OF HEAVY OIL-DEGRADING BACTERIA IN THE OIL-POLLUTED AREAS CAUSED BY THE MIZUSHIMA OIL SPILL ACCIDENT (IN JAPANESE),
Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.
For primary bibliographic entry see Field 5C.
W89-06601

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME II.
McNeese State Univ., Lake Charles, LA.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-002684. Price codes: A18 in paper copy, A01 in microfiche. Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report 496p. DOE Grant DE-FG01-83EP31111. Edited by L. R. DeRouen and L. Harold Stevenson.

Descriptors: *Estuarine environment, *Surveys, *Louisiana, *Calcasieu Lake, *Calcasieu River, *Ecosystems, Ecological effects, Phytoplankton, Zooplankton, Diatoms, Water quality, Eutrophication, Benthic environment, Nekton, Water pollution effects.

The Calcasieu River/Lake Complex is an important resource in southwestern Louisiana. The watershed of the system has been developed by municipal, industrial, and agricultural interests, and the waterways are used for waste discharge, transportation, recreation, and commercial fisheries. Because of the multiple uses of the system, there is a potential for degradation of the estuary. This document reports on research undertaken in an effort to understand the basic ecology of the Calcasieu River/Lake Complex and to evaluate the effects of human activities on that ecology. Part of the work involved surveying the Calcasieu Estuary for the presence of anthropogenic substances as well as analyses of the effects of human activities on the biotic communities within the estuary. The field sampling and monitoring were conducted from October 1983 through August 1986. Routine sampling locations were located throughout the estuary from the sale water barrier on the Calcasieu River north of Interstate 10 to the mouth of the system at Cameron. This volume II, presents reports which discuss: (1) primary producers, with respect to phytoplankton, diatoms, and bluegreen algae are indicators of water quality, eutrophication, and ecological effects of water pollutants; (2) zooplankton; (3) benthos and trophic structure and the effects of pollutants on macrobenthic communities; and (4) nekton assemblages of the Calcasieu River/Lake complex. (See W89-06606 thru W89-06622) (Lantz-PTT)
W89-06605

CHECKLIST OF PHYTOPLANKTON FOR THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
R. S. Maples.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/311111--1-Vol. 2, June 26, 1987. Final Report. p 74-86, 8 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Phytoplankton, *Species composition, *Estuaries, *Louisiana, *Calcasieu River, *Calcasieu Lake, Surveys, Ecosystems, Taxonomy, Plankton, Diatoms.

A checklist of phytoplankton taxa for the Calcasieu River/Lake Complex, Louisiana, is presented. A total of 115 taxa representing 61 genera is reported. The most frequently encountered taxa were species of Asterionella, Chaetoceros, Coscinodiscus, Navicula, Odontella, Pleurosigma, Rhizosolenia, Skeletonema, Thalassiosira, and Thalassiothrix. Chaetoceros, Rhizosolenia, and Nitzschia had the largest number of species. The diatoms dominated the phytoplankton for most of the year. Substantial populations of dinoflagellates and micro flagellates were present in the spring and summer months. A bluegreen alga was abundant at one station in the spring of 1984. (See also W89-06605) (Author's abstract)
W89-06606

DIATOMS AS INDICATORS OF WATER QUALITY IN THREE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
R. S. Maples.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 87-103, 1 fig, 4 tab, 13 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Estuarine, *Bioindicators, *Diatoms, *Louisiana, *Water quality, *Bayous, *Calcasieu River, *Calcasieu Lake, Ecosystems, Ecological effects, Eutrophication, Water pollution sources, Wastewater, Urban runoff.

A total of 99 periphytic diatom taxa were collected in three bayous of Calcasieu Estuary, Louisiana. Eutrophic and mesotrophic species were identified and found to be widespread in all three bayous. The most common eutrophic taxa were Cyclotella meneghiniana Kutz., Gomphonema parvulum Kutz., Nitzschia ganderscheimiensis Krasske and Nitz. palea (Kutz.) W. Sm. The absence of pollution-sensitive taxa and high autotrophic index values in Contraband Bayou indicated that this bayou was at a critical level of eutrophication. The pollution was attributed to a sewage outfall near the mouth of Contraband Bayou, urban runoff, urban activities (e.g., discarding grassclippings in the bayou), and summer stagnation of the water column. (See also W89-06605) (Author's abstract)
W89-06607

BLUEGREEN ALGAE AS INDICATORS OF EUTROPHICATION IN THREE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
R. S. Maples.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 104-113, 1 fig, 2 tab, 12 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Estuaries, *Bioindicators, *Cyanophyta, *Algae, *Eutrophication, *Bayous, *Calcasieu River, *Calcasieu Lake, Water quality, Estuaries, Wetlands, Ecosystems, Hydrogen ion concentration, Nutrients, Temperature, Eutrophication.

A total of fifteen bluegreen algal taxa were collected in three bayous of Calcasieu Estuary, Louisiana. Eutrophic and mesotrophic species were identified and found to be widespread in all three bayous. The most common taxa were Anacystis montana (Lightfoot) Drouet and Daily, Oscillatoria lutea Ag., Microcoleus lyngbyaceaus (Kutz.) Crouan, and Schizothrix calcicola (Ag.) Gomont. An ecological profile sheet on several common taxa was prepared which included pH, saprobic index, nutrients, halobion, temperature, habitat, and season. Based on the total number of taxa present in the samples, Contraband Bayou and Bayou d'Inde show the greatest tendency toward a eutrophic status. (See also W89-06605) (Author's abstract)
W89-06608

PHYTOPLANKTON ECOLOGY OF CALCASIEU LAKE, LOUISIANA,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.

R. S. Maples.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 114-152, 5 fig, 9 tab, 34 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Estuaries, *Phytoplankton, *Ecosystems, *Louisiana, Biomass, Primary productivity, Species diversity, Tidal currents, Mixing, Chlorophyll a, Seasonal variation, Calcasieu Lake, Diatoms, Dinoflagallates.

Phytoplankton community structure, biomass, and primary productivity were investigated for Calcasieu Lake, Louisiana. Calcasieu Lake is one of four broad, shallow, turbid estuarine lakes in Calcasieu Estuary. Marine and euryhaline diatoms dominated the phytoplankton community for most of the year with substantial populations of dinoflagellates and microflagellates present in the spring and summer months. Species diversity, redundancy, and niche breadth values were calculated to aid the interpretation of an extremely patchy phytoplankton community. All stations were strongly influenced by tidal circulation and had very high salinity (S.I.M.I.) values. Chlorophyll a values were elevated in the summer and winter months. A comparison of water column nutrients (NO_2+NO_3, NH_3, PO_4) with annual chlorophyll a values indicated that nutrients were not a limiting factor for phytoplankton productivity. Phytoplankton primary productivity is subject to seasonal variability but acute changes in biomass (chlorophyll a) and productivity occur in relation to meteorologic and hydrologic events, e.g., rainfall and riverine flow. A comparison of phytoplankton growth with a previous study indicated that there has not been any substantial change in the health of the phytoplankton community of Calcasieu Lake from 1980-1985. (See also W89-06605) (Author's abstract)
W89-06609

ZOOPLANKTON IN THE CALCASIEU RIVER/LAKE COMPLEX: RATIONALE, GENERAL METHODS, AND METHOD VERIFICATION,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
M. Vecchione.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/311111--1-Vol. 2, June 26, 1987. Final Report. p 153-184, 14 fig, 22 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Zooplankton, *Estuaries, *Sampling, *Biological samples, *Experimental design, *Calcasieu River, *Calcasieu Lake, Fish, Crustaceans, Taxonomy, Population distribution, Distribution patterns, Species diversity, Bayous.

Chenier-Plain estuaries are unique, yet have not been studied in detail. The zooplankton of one such estuary, the Calcasieu Estuary in southwestern Louisiana, was studied during a 31-month period (September 1983 - April 1986) with several objectives. A series of presentations describes: (1) long-term patterns in the distribution and abundance of the copepod Acartia tonsa; (2) the distributions of zooplankton in three estuarine bayous that are subject to different anthropogenic stresses; (3) the overall distributional patterns of zooplankton throughout the estuary; and (4) the incidence of ectoparasitic copepods on ichthyoplankton. This paper describes the general methods that were common to all of these projects and presents the results of some projects designed to determine the limits of these data. The principal sampling strategy consisted of a triplicate series of one-minute tows made with a 0.5-m ring net of 0.153-mm netting and a soft cod end. Several hydrographic parameters were also measured at each station; temperature, conductivity, dissolved-oxygen concentration, and pH were each measured at 1-m intervals from the bottom to the surface, and Secchi-disk depth was determined. These methods were used over a 31-month period (September 1983 to April 1986) at 33 stations located throughout the Calcasieu Estuary from the saltwater barrier north of Lake Charles to Calcasieu Pass near Cameron. All fish larvae and postlarvae, and shrimp postlarvae were sorted from all samples. Each sample was also sorted for fish eggs, decapod larvae, copepods, and numerically-dominant zooplankton. The copepod Acartia tonsa overwhelmingly dominated the numbers of animals collected. The numerically-dominant fish from the summer assemblage were Anchoa spp. Decapod crustacean larvae proved to be speciose but very patchy in distribution. Changes in abundance on a temporal scale of hours or a spatial scale of a few km unquestionably affect comparative studies but in a magnitude and pattern that cannot be predicted based simply on assumptions of vertical migration or tidal transport. For comparative purposes it is necessary to select species with the least-observed variance in abundance on these scales. (See also W89-06605) (Author's abstract)
W89-06610

LONG-TERM TRENDS IN THE ABUNDANCE OF ACARTIA TONSA IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
M. Vecchione.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 185-201, 5 fig, 15 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Louisiana, *Copepods, *Population dynamics, *Estuaries, *Calcasieu River, *Calcasieu Lake, *Population density, Salinity, Water temperature, Mixing.

Data on the abundance of adult Acartia tonsa are combined from three data sets. These data were all collected by similar methods at two stations in Calcasieu Lake and included samples taken during 51 months over a 132 month period (1975-1986). Both mean abundance and maximum abundance increased by a factor of a 2 and then decreased to the original levels during this period. Although there was a slight trend of increasing abundance overall, this trend was not statistically significant. All samples that included high abundances (> 10,000 individuals /cu m) were collected when the water column was not stratified in either salinity or temperature, probably indicating an interacation between wind mixing of this very shallow water column and the vertical distribution of A. tonsa. (See also W89-06605) (Author's abstract)
W89-06611

ZOOPLANKTON DISTRIBUTION IN THREE ESTUARINE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX WITH DIFFERENT TYPES OF ANTHROPOGENIC INFLUENCE,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5C.
W89-06612

ZOOPLANKTON DISTRIBUTION IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
M. Vecchione.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 237-254, 9 fig, 12 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Zooplankton, *Distribution patterns, *Estuaries, *Louisiana, *Calcasieu River, *Calcasieu Lake, Copepods, Fish, Taxonomy, Species composition.

The overall distribution of five major zooplankton taxa is summarized based on six sets of synoptic samples collected at stations throughout the Calcasieu Estuary. The taxa were: The copepods Acartia tonsa, Paracalanus crassirostris, and Eurytemora affinis and the fish Brevoortia sp. and Anchoa spp. Although A. tonsa were collected throughout the year they were much more abundant during May-September than during the colder months. P. crassirostris was particularly abundant in September, when it was found throughout Calcasieu Lake, the lower ship channel, and Choupique Bayou. E. affinis was typically found in the upper ship channel and bayous; however, on May 6 1984 maximum abundance, although low when compared with that in March and July was shifted to the south ends of both Calcasieu Lake and the ship channel. Postlarval menhaden (Brevoortia) alternate with anchovies (Anchoa) as seasonal dominants of the ichthyoplankton, with menhaden numerous throughout the cooler months and anchovies distributed bimodally in warmer months, exhibiting decreased abundance during midsummer. (See also W89-06605) (Lantz-PTT)
W89-06613

INCIDENCE OF ECTOPARASITIC COPEPODS ON ICHTHYOPLANKTON IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
S. M. Felley, M. Vecchione, and S. G. F. Hare.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 255-272, 5 fig, 1 tab, 13 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Fish parasites, *Zooplankton, *Ecosystems, *Copepods, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Estuaries, Fish, Salinity, Parasites, Sublethal effects, Water pollution effects.

The incidence of ectoparasite copepods on ichthyoplankton in Calcasieu Estuary, Louisiana, was examined. Although relationships between parasitic copepods and fishes are well documented, there have been no studies that deal specifically with infestations on larval or postlarval fishes. In this study, infestations were found in only three taxa: Anchoa spp. (3.6%), Brevoortia sp. (0.2%), and Gobiidae (4.4%). Although 36.4% of the fish examined (n = 27,167) were larvae, only postlarval fishes were infested. The parasites are believed to be members of the order Siphonostomatoida. The sites of parasite attachment were completely constant within each fish taxon but differed among taxa. All copepods parasitic on Anchoa sp. were attached on the dorsal surface. Those found attached to Brevoortia sp. were located on the ventral surface. All copepods parasitic on Gobiids were found laterally on the caudal peduncle. The distribution of parasitized fishes was examined in comparison with the overall distribution of the species. Parasitized Brevoortia were generally found in low salinity water (< 10 parts per thousand) but no taxon appeared to be associated with any particular temperature range. The distribution of parasitized gobiids appeared to be very restricted, but this was probably an artifact of collection methods. The incidence of parasites was examined as a possible indicator of sublethal stress in the ecosystem. It was hypothesized that rates of parasitism would be higher in more heavily polluted areas of the estuary. These data proved to be inadequate to address this hypothesis because the numbers of fishes in the two polluted bayous, Contraband and d'Inde, were consistently so low that parasitism rates as high as 25% would not have been detectable. (See also W89-06605) (Author's abstract)
W89-06614

INTRODUCTION AND METHODS: BENTHOS,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5C.
W89-06615

TROPHIC STRUCTURE OF ESTUARINE MACROBENTHOS IN CALCASIEU LAKE, LOUISIANA,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston, D. L. Leo, and J. C. Nasci.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 284-317, 4 fig, 5 tab, 46 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Trophic level, *Estuaries, *Benthos, *Calcasieu Lake, *Louisiana, Polychaetes, Oligochaetes, Amphipods, Seasonal variation, Nutrients.

Benthic assemblages in Calcasieu Lake (Louisiana) were studied at 11 sampling sites from October 1983 through November 1985. The sites were numerically dominated by subsurface-deposit feeders, consisting mostly of polychaetes. Greater densities of macrofauna were collected in the northern (upper) sites of the lake than were collected in West Cove or the southern sites. Abundances in the upper lake stations of polychaetes, oligochaetes, and amphipods accounted for most of the discrepancy among sites. Trophic groups of macrofauna and macrofuanal abundances were without consistent seasonal pattern, perhaps due to the abundance of nutrients in the estuary throughout the year. The dominance of subsurface-deposit feeders may be additional evidence that substantial sedimented nutrients are buried below the sediment-water interface in Calcasieu Lake; thus those nutrients are available only to species that live below the sediment surface. (See also W89-06605) (Author's abstract)
W89-06616

TROPHIC STRUCTURE OF MACROBENTHIC COMMUNITIES IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 318-372, 4 fig, 5 tab, 44 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Trophic level, *Benthos, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Ecosystems, Estuaries, Flow discharge, Food habits, Species composition, Ecological effects, Sediment-water interface.

Trophic groups were used to investigate broad patterns and predict species interactions of macrobenthic assemblages in Calcasieu Estuary, Louisiana. Benthic assemblages of the estuary were numerically dominated by deposit-feeding species. Surface-deposit feeders were the most abundant macrobenthos of the upper estuary, subsurface-deposit feeders dominated the lower estuary, and a trophically well-mixed assemblage inhabited the middle estuary. There were periodic shifts in species dominance within each region, but the shifts were without temporal pattern and seldom led to changes in trophic structure of the region. The upper estuary was dominated by several early-colonizing species which were able to switch feeding mode with changes in water flow. Dominance by such species may suggest that disturbance in the upper estuary had a direct effect on macrobenthic communities. Disturbances may have eliminated macrobenthic species before they could establish a well-mixed community. Trophically mixed communities of the middle estuary probably were indicative of fewer disturbances there. The dominance of the lower estuary by subsurface-deposit feeders probably indicates that sedimenting food in Calcasieu Lake was not utilized at the sediment-water interface, but became buried and thus was available only to subsurface-deposit feeders. (See also W89-06605) (Author's abstract)
W89-06617

EFFECTS OF POLLUTANTS ON MACROBENTHIC COMMUNITIES IN THE UPPER CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 5C.
W89-06618

TROPHIC GROUPS OF MACROBENTHOS IN THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 390-405, 1 fig, 1 tab, 6 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Benthic fauna, *Food habits, *Benthos, *Trophic levels, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Estuaries, Parasites, Herbivores, Carnivores.

Macrobenthic species of the Calcasieu Estuary were categorized into seven trophic groups: surface-deposit feeders; subsurface-deposit feeders; suspension feeders; carnivores; herbivores; parasites; and omnivores. Classification for the 118 taxa collected were based primarily on available literature. However, species which could not be confidently classified using available literature were dissected for analysis of gut contents or maintained in laboratory aquaria for observation of feeding mode. Most species and most members of macrobenthic assemblages in the Calcasieu Estuary were deposit feeders. Carnivores were the next largest trophic group, though they represented far fewer individuals. Only a few taxa were omnivorous, and parasites and herbivores were represented by a single species each. (See also W89-06605) (Author's abstract)
W89-06619

NEKTON ASSEMBLAGES OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
J. D. Felley.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report Sampling Dates: October 1983-August 1986. p 406-496, 7 fig, 6 tab, 49 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Species diversity, *Nekton, *Calcasieu River, *Calcasieu Lake, *Water pollution effects, *Estuaries, Louisiana, Bayous, Wetlands, Ecological effects, Industrial wastewater, Statistical analysis, Species composition, Oxygen requirements, Channeling, Municipal wastewater, Commerical fishing, Shrimp, Menhaden, Drum.

Species of nekton were sampled monthly by trawl in Calcasieu Lake, a chenier-plain estuary, from October 1983 to August 1986. Additionally, nekton species were sampled monthly by seine in Calcasieu Lake and in three bayous that feed into the estuary, from September 1985 to August 1986. For each sample, number of individuals and total biomass of each species was recorded. Also, individuals of commercially important species (penaeid shrimps, Brevoortia spp., sciaenids) were weighed and measured. For purposes of analysis, three different data sets were defined, as follows: (a) trawl samples from Calcasieu Lake; (b) seine samples from Calcasieu Lake; and (c) seine samples from three bayous (bayous Choupique, Contraband and d'Inde). For each data set, detrended correspondence analysis (DCA) was performed on a species-by-sample matrix containing numbers of individuals of all species sampled. Of the three bayous sampled, Choupique Bayou was comparatively unaffected by human activities. Contraband Bayou and Bayou d'Inde have been highly modified by human activities; both have been dredged and channelized along portions of their lengths, and both receive wastes from municipal sewage treatment plants. In addition, Bayou d'Inde receives industrial waste from a large petrochemical complex. Choupique Bayou was quite rich in species, with an average of 23.7 species sampled each month. The species found in Contraband Bayou were a subset of those found in Choupique Bayou. Samples from Contraband Bayou averaged 14.8 species each month, but lacked many oxygen-sensitive species found in Coupique Bayou. Species found in Bayou d'Inde were a restricted subset of those found in Contraband Bayou (average of 10.1 species sampled each month). Most of the species inhabiting Bayou d'Inde were relatively less abundant than in Contraband Bayou. The results of this study suggest that human activities dramatically reduced the number of species found in a bayou, and reduced the value of the bayou as a nursery area for commercially important species. (See also W89-06605) (Lantz-PTT)
W89-06620

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME III.
McNeese State Univ., Lake Charles, LA.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-003685. Price codes: A18 in paper copy, A01 in microfiche. Report No. DOE/EP/31111--1-Vol. 3, June 27, 1987. Final Report, Sampling Dates: October 1983 - August 1986. DOE Grant DE-FG01-83EP31111.

Descriptors: *Estuarine environment, *Calcasieu River, *Calcasieu Lake, *Hydrologic studies, *Ecosystems, *Louisiana, *Mathematical models, Salinity, Mixing, Simulation analysis, Flow profiles, Sediment distribution, Model studies.

The main components of this report were: (1) the numerical modeling of circulation and dispersion characteristics in Calcasieu Lake; (2) salt flux computations in the bayous, used as a means of describing the hydrographic features of the inner portions of the Calcasieu system; and (3) time series current meter moorings in Calcasieu Lake. The main accomplishment was the implementation of the hydrodynamic/dispersion model. The model is a vertically-integrated finite-difference, unsteady, full nonlinear numerical model, implemented on a DEC VAX 11/780 system under VMS. The model is tidally forced at Calcasieu Pass, accepts fresh water input from multiple rivers, and has a homogeneous steady wind stress. Besides yielding flow field, changes in sea level, salinity, and sediment distributions for Calcasieu Lake were also simulated. A thorough validation of the model is required. This is a highly desirable future work task. A simulation model is a powerful tool in testing hypotheses and in planning field sampling, but any model has limitations. In this case, the complex effects introduced by gravitational circulation in the Calcasieu Ship Channel are not properly included. (See also W89-06605 and W89-06622) (Author's abstract)
W89-06621

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME IV.
McNeese State Univ., Lake Charles, LA.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-002686. Price codes: A22 in paper copy, A01 in microfiche. Report No. DOE/EP/31111--1-Vol. 4, June 26, 1987. 576p. DOE Grant DE-FG01-83EP31111.

Descriptors: *Ecosystems, *Water pollution effects, *Calcasieu River, *Estuarine environment, *Data collections, *Calcasieu Lake, *Louisiana, Ecological effects, Zooplankton, Benthos, Water quality, Primary productivity, Chemical analysis, Nekton, Watersheds.

The Calcasieu River/Lake Complex is an important resource in southwestern Louisiana. The watershed of the system has been developed by municipal, industrial, and agricultural interests, and the waterways are used for waste discharge, transportation, recreation, and commercial fisheries. Because of the multiple uses of the system, there is a potential for degradation of the estuary. This document reports on research undertaken in an effort to understand the basic ecology of the Calcasieu River/Lake Complex and to evaluate the effects of human activities on that ecology. Part of the work involved surveying the Calcasieu Estuary for the presence of anthropogenic substances as well as analyses of the effects of human activities on the biotic communities within the estuary. The field sampling and monitoring were conducted from October 1983 through August 1986. Routine sampling locations were located throughout the estuary from the salt water barrier on the Calcasieu River north of Interstate 10 to the mouth of the system at Cameron. This volume, the final volume of a four volume series contains seven appendices to the main report. They are: (1) Supporting data

for water quality and special pollutants; (2) Supporting data for chemistry; (3) Supporting data for primary producers; (4) Supporting data for zooplankton; (5) Supporting data for benthos; (6) Supporting data for nekton; and (7) Supporting data for hydrology. (See also W89-06605 and W89-06621) (Lantz-PTT)
W89-06622

MULTIPLY-CONNECTED CHANNEL MODE OF TIDES AND TIDAL CURRENTS IN PUGET SOUND, WASHINGTON AND A COMPARISON WITH UPDATED OBSERVATIONS,
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
J. W. Lavelle, H. O. Mofjeld, E. Lempriere-Doggett, G. A. Cannon, and D. J. Pashinski.
Available from National Technical Information Service, Springfield, VA 22161, as PB89-139786. Price codes: A06 in paper copy; A01 in microfiche. NOAA Technical Memorandum ERL PMEL-84, November 1988. 103p, 35 fig, 14 tab, 36 ref.

Descriptors: *Tidal hydraulics, *Mathematical models, *Puget Sound, *Tidal currents, *Tides, *Washington, Model studies, Tidal amplitude, Channels, Model testing, Tidal energy, Tidal prism.

Tides and tidal transports within Puget Sound have been calculated using a model in which the Sound is represented by 79 channels connected at 43 junctions. Linearized equations of motion were used to determine channel cross-sectionally averaged quantities for the principal tidal constituents (M sub 2, K sub 1, S sub 2, N sub 2, O sub 1, P sub 1, M sub 4). For the M sub 2 tide the amplitudes and phases at the entrances to the Sound and the friction coefficients in the channels were adjusted to bring observed and modeled tidal distributions into best agreement; for other constituents, only the tidal amplitudes and phases at the entrances were adjusted. Data from 47 tide stations in Puget Sound were used for fitting model parameters. Tidal amplitudes and phases match observations with an average difference of less than 1 cm and 2 degrees, respectively for each of the constituents indicated. Transport values from the model were subsequently compared to transports calculated from currents measured on four sections across the Sound at both M sub 2 and K sub 1 frequencies. Tidal transports at the M sub 2 frequency match the transports ca'culated from the data with average difference of $< 3\%$ for amplitude and 4.3 degrees for phase. The model was also used to calculated cross-sectionally averaged tidal currents, tidal prisms, and tidal dissipation rates for the composite tide and for constituents. As an example of those results, the composite tide and the M sub 2 and K sub 1 constituents have tidal prisms or 7.69, 4.74 and 3.73 cu km and dissipation rates of 733, 528 and 78 MW, respectively. (Author's abstract)
W89-06632

AQUATIC SURFACE MICROLAYER CONTAMINATION IN CHESAPEAKE BAY,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
For primary bibliographic entry see Field 5B.
W89-06657

BENEFICIAL USES OF DREDGED MATERIAL IN SHALLOW COASTAL WATERS; CHESAPEAKE BAY DEMONSTRATIONS,
Corps of Engineers, Baltimore, MD. Baltimore District.
For primary bibliographic entry see Field 5E.
W89-06667

BIOCHEMICAL CHARACTERIZATION OF ESTUARINE BENTHIC MICROBIAL COMMUNITIES FOR USE IN ASSESSING POLLUTION IMPACTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5C.
W89-06735

MARINE SEDIMENT TOXICITY TESTS,
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
For primary bibliographic entry see Field 5A.
W89-06739

TOXICITY OF U.S. WATERWAY SEDIMENTS WITH PARTICULAR REFERENCE TO THE NEW YORK HARBOR AREA,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5C.
W89-06740

DETERMINATION OF ORGANIC CHEMICALS IN SEDIMENTS TAKEN FROM THREE UNPOLLUTED ESTUARIES IN SOUTHWEST ENGLAND,
Imperial Chemical Industries Ltd., Brixham (England). Brixham Lab.
For primary bibliographic entry see Field 2J.
W89-06763

INTERDISCIPLINARY APPROACH TO VALUATION OF MICHIGAN COASTAL WETLANDS,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6B.
W89-06879

CHANGES IN TIDAL FLOW, CIRCULATION, AND FLUSHING CAUSED BY DREDGE AND FILL IN TAMPA BAY, FLORIDA,
Geological Survey, Tampa, FL. Water Resources Div.
C. R. Goodwin.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water-Supply Paper 2282, 1987. 88p, 61 fig, 19 tab, 41 ref.

Descriptors: *Circulation, *Flushing, *Model studies, *Dredge and fill, *Estuaries, *Bays, *Water circulation, *Florida, Tampa Bay, Tides, Two-dimensional models.

Tampa Bay, Florida, has undergone extensive physical changes due to construction of causeways, islands, channels, and shoreline fill. These changes have caused a 6% reduction in the quantity of water that enters and leaves the bay due to tidal action. A two-dimensional computer model was used to simulate changes in both tidal and residual, water and constituent transport between 1880, 1972, and projected for 1985. Computations revealed tide-induced circulation patterns in 1880 consisting of 20 interconnected circulatory features that ranged in diameter from 1 to 6 mi. Circulation decreased about 45,000 cu ft/sec at the Gulf of Mexico to zero at the head of Hillsborough and Old Tampa Bays with a striking exception in mid-Tampa Bay. A 10-mile section was found to have exceptionally low average circulation, 5,000 cu ft/sec, that restricted the interchange of water and constituents. Changes in size, position, shape, and intensity of circulatory features since 1880, caused by dredge and fill construction, increased tide-induced circulation and flushing throughout most of the bay. A computed 29% circulation increase in the restricted section may have contributed to increased bay salinity and more rapid flushing of contaminants from the bay to the Gulf of Mexico. (USGS)
W89-06893

STUDY OF THERMALLY INDUCED TIME-DEPENDENT CANISTER MIGRATION,
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-06926

GEOCHEMISTRY OF COPPER AND CHROMIUM ORGANIC COMPLEXES IN NARRAGANSETT BAY INTERSTITIAL WATERS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
G. S. Douglas.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627621. Ph.D. Dissertation, 1986. 198p, 32 fig, 11 tab, 103 ref.

Descriptors: *Geochemistry, *Estuaries, *Narragansett Bay, *Copper, *Chromium, *Interstitial water, *Metal complexes, *Trace metals, Dissolved solids, Estuarine environment, Sediments, Rhode Island.

Dissolved organic copper and chromium complexes were measured in both overlying and interstitial water of Narragansett Bay and mesocosm sediments using C18 reverse-phase chromatography and atomic absorption spectroscopy. In the interstitial and overlying water, the isolation procedure recovered 22-67% of the total dissolved copper, 23-55% of the total dissolved chromium and 14-40% of the dissolved organic copper. In a second study, interstitial water copper-organic complexes were isolated from sediments from the Narragansett Bay and a series of experimental mesocosms. Interstitial dissolved copper generally decreased with depth to a relative constant value, although concentration maxima were usually seen within the upper parts of the cores due to remobilization processes. In a third study, C18 reverse-phase liquid chromatography and atomic absorption spectroscopy were used to isolate and quantify dissolved interstitial chromium-organic complexes in Narragansett Bay sediments. The concentration of total and organic chromium (22-53% of the total chromium) increased with depth in the core and appeared to be remobilized from a chromium-silica-organic matter solid phase. (Cremmins-AEPCO)
W89-06931

FINITE ELEMENT MODELING OF SHALLOW WATER WAVES,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W89-06960

3. WATER SUPPLY AUGMENTATION AND CONSERVATION

3A. Saline Water Conversion

DESALINATION COSTS IN AUSTRALIA; A SURVEY OF OPERATING PLANTS,
Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Ian Wark Labs.
B. R. Smith, and E. A. Swinton.
Desalination DSLNAH, Vol. 70. No. 1-3. p 3-15, November 1988. 5 fig, 2 tab, 13 ref.

Descriptors: *Desalination, *Capital costs, *Cost analysis, *Australia, Comparison studies, Desalination plants, Brackish water, Seawater, Reverse osmosis, Electrodialysis.

A survey of desalination costs in Australia was conducted using data obtained from plant operators. Results are reported in second quarter 1986 Australian dollars. Unit water costs range from $0.76/kL (for a precursor to deionization for boiler feed) to $14/kL (for emergency supplies for an island resort). However, an average figure for desalination of brackish water is $3-$4/kL, and for seawater, $5-10/kL in medium-sized installations. Capital costs for brackish water plants have been correlated with plant design capacity ranging from 10 to 3400 kL/day. There is insufficient information to allow a proper comparison between reverse osmosis and electrodialysis for brackish water desalination. (Author's abstract)
W89-06495

DESALINATION OF NON-CHLORINATED SURFACE SEAWATER USING TFC MEMBRANE ELEMENTS,

Group 3A—Saline Water Conversion

Allied-Signal, Inc., San Diego, CA. UOP Fluid Systems.
W. G. Light, J. L. Perlman, A. B. Riedinger, and D. F. Needham.
Desalination DSLNAH, Vol. 70, No. 1-3, p 47-64, November 1988. 6 fig, 2 tab, 9 ref.

Descriptors: *Membranes, *Desalination, *Reverse osmosis, *Saudi Arabia, *Seawater, Thin films, Red Sea, Fouling, Copper sulfate, Membrane processes, Chlorination.

The Umm Lujj II reverse osmosis (RO) desalination plant in Saudi Arabia has produced high quality potable water (<200 mg/L total dissolved solids (TDS) concentration) at better than design capacity (4,400 cu m/day (1.16 MGD)) from non-chlorinated Red Sea surface seawater (42 g/L TDS concentration) since May 1986. The plant employs thin-film composite (TFC) spiral-wound membrane elements manufactured by UOP Fluid Systems. During the two years of operation, there have been no element additions or replacements and no element cleaning has been required. The only meaningful biological concern for surface seawater RO plants containing TFC membrane is algae growth, which is effectively controlled by a low concentration of copper sulfate. The seawater is not pretreated with a general disinfectant such as chlorine because other live microorganisms in the surface seawater do not attack or excessively foul UOP's TFC membrane. There has been no evidence of fouling by microorganisms or other foulants at Umm Lujj. This is reflected in the normalized membrane water flux after the two-year period being at the predicted value for a non-fouling feedwater. It is proposed that the long-term stability of TFC membrane with non-chlorinated surface seawater is due to its surface properties. (Author's abstract)
W89-06496

NANOFILTRATION MEMBRANES BROADEN THE USE OF MEMBRANE SEPARATION TECHNOLOGY,
FilmTec Corp., Minneapolis, MN.
J. Cadotte, R. Forester, M. Kim, R. Petersen, and T. Stocker.
Desalination DSLNAH, Vol. 70, No. 1-3, p 77-88, November 1988. 3 fig, 9 tab, 4 ref.

Descriptors: *Membranes, *Separation techniques, *Water treatment, *Desalination, *Reverse osmosis, *Filtration, Polymers, Brackish water, Electroplating, Potable water, Performance evaluation, Food-processing industry.

Most reverse osmosis (RO) research has concentrated on the development of single-pass seawater membranes. The success of these high rejection membranes has created interest in other applications requiring less demanding salt rejection, or desiring the elimination of salt from a feed stream (diafiltration), or having severe chemical resistance requirements. All would prefer to operate at lower net driving pressures than demanded by the high rejection membranes. This paper reports on the characteristics of three such tailored membranes. These membranes have been designated as nanofiltration membranes to distinguish them from the hyperfiltration seawater membranes. The first is XP45, a polyamide membrane with a low sodium chloride rejection that makes it an excellent candidate for applications such as the processing of salty cheese wheys and pharmaceutical preparations. The second is NF70, another polyamide, a low pressure membrane with rejections suited for converting mildly brackish water and organic-laden raw water to potable water that meets WHO standards. The third is XP20, a new developmental membrane for the maintenance of electroless copper plating baths. (Author's abstract)
W89-06497

COMPOSITE MELAMINE-FORMALDEHYDE-FURFURALCOHOL COPOLYMERIZATION MEMBRANE FOR REVERSE OSMOSIS,
Tianjin Inst. of Textile Science and Technology (China).
W. Wentong.
Desalination DSLNAH, Vol. 70, No. 1-3, p 137-142, November 1988. 4 tab, 3 ref.

Descriptors: *Reverse osmosis, *Desalination, *Semipermeable membranes, *Polymers, Separation techniques, Membranes processes, Catalysts, Sulfuric acid, Filter media, Sodium chloride, Membranes, Salt resection, Wettability, Materials testing.

The preparation and performance of a new composite reverse osmosis membrane, composed of a microporous substrate and a barrier layer having cross-linked polymeric material copolymerized by trihydroxymethyl-melamine (TMM) and furfuralcohol (FA) were investigated. The ultrathin semipermeable barrier of the composite TMM-FA copolymerization membrane for reverse osmosis is formed on the porous surface of polysulfone support membrane by copolymerization between melamine-formaldehyde prepolymer and furfuralcohol under sulfuric acid catalyst. In the condition of operation pressure 20 kg/sq cm and concentrated water flux 20 L/hr, the membrane has 95% rejection and 0.3 cu m/sq m-day flux for 1500 ppm aqueous sodium chloride. The factors affecting the reverse osmosis performance of the composite membrane, such as amount of the prepolymer catalyst and additives were also investigated. The addition of TMM changed the structure of FA polymer and increased the flux of the composite membrane. When the amount of prepolymer TMM in the coating solution was increased, the sodium chloride rejection was firstly increased and then the rejection decreased rapidly while flux increased. The optimum concentration of TMM and FA in the solution under the conditions of the experiment was 1 and 2% by weight respectively. The optimum concentration of sulfuric acid catalyst in the coating solution under conditions of the experiment was 2.5% by weight. Additives in the coating solution may be used to improve the pot life of the coating solution and the surface wettability of the substrate. An effective cure temperature range between 120 and 180 C was demonstrated. (Geiger-PTT)
W89-06498

OXIDATION OF FORMALDEHYDE SOLUTIONS USED FOR THE PRESERVATION OF REVERSE OSMOSIS MEMBRANES: PHASE II,
Water and Power Resources Service, Denver, CO. Engineering and Research Center.
For primary bibliographic entry see Field 5F.
W89-06627

3B. Water Yield Improvement

OPERATING POLICIES FOR RESERVOIR PUMPED-WATER INTERTIES,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
E. E. Whitlatch, N. R. Bhaskar, and M. J. Martin.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 687-703, November 1988. 6 fig, 3 tab, 16 ref, 2 append.

Descriptors: *Interbasin transfer, *Water yield improvement, *Water supply, *Reservoir operation, *Pumping, Stochastic process, Optimization, Ohio, Statistical methods, Water conveyance, Case studies, Cost analysis, Water shortage.

One means to increase effective water supply yield is to have pumped-water intertie of reservoirs. The management of Hoover Reservoir and its associated pumped-water intertie with Alum Creek Reservoir in the water supply system of Columbus, Ohio, is examined using the method of implicit stochastic optimization. Optimal monthly pumping policies are derived in a multiobjective environment involving trade-offs of pumping and water supply shortage costs, target draft rates, and reliability levels. Policies heuristically derived from a dynamic programming formulation are tested for statistical performance using simulation, and are parametrically varied to determine the most cost-effective policies for a given reliability level and draft rate. Multiobjective trade-off analysis can then be carried out between pumpage cost, target draft rate, and reliability. In the case study, significant net savings result from the use of pumped water rather than alternative water supply sources due to lower softening costs, and a savings maximization procedure is developed. The advantages and disadvantages of implicit stochastic optimization are highlighted. (Author's abstract)
W89-05821

FUTURE LEGAL REGULATION OF WEATHER MODIFICATION,
Brigham Young Univ., Provo, UT. J. Reuben Clark Law School.
For primary bibliographic entry see Field 6E.
W89-05965

MICROPHYSICAL EFFECTS OF WINTERTIME CLOUD SEEDING WITH SILVER IODIDE OVER THE ROCKY MOUNTAINS: I. EXPERIMENTAL DESIGN AND INSTRUMENTATION,
Bureau of Reclamation, Denver, CO.
A. B. Super, B. A. Boe, and E. W. Holroyd.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 10, p 1145-1151, October 1988. 29 ref.

Descriptors: *Orographic precipitation, *Micrometeorology, *Experimental design, *Measuring instruments, *Cloud seeding, *Silver iodide, *Weather modification, *Rocky Mountains, Supercooled liquid water, Ice, Aircraft.

Several winter orographic cloud seeding experiments were carried out over mountain barriers in Montana and Colorado. Silver iodide was released either on the windward slope or by aircraft. Recent advances in technology made it feasible to detect: (1) the silver iodide in-cloud to within 300 m of each target area's highest terrain, (2) corresponding changes in ice particle concentration, habits and sizes, and (3) corresponding changes in supercooled liquid water content. Relative changes in the precipitation rate were estimated at aircraft levels with a recently developed computerized approach. In addition, surface observations of seeding-induced changes in ice particle characteristics and precipitation were made in Colorado. In the first of a three-part study, the experimental design and physical hypothesis underlying the experiments are described and the instrumentation used, its associated calibrations and limitations and the methodology employed in each type of experiment are discussed in detail. (See also W89-06000 and W89-06001) (Miller-PTT)
W89-05999

MICROPHYSICAL EFFECTS OF WINTERTIME CLOUD SEEDING WITH SILVER IODIDE OVER THE ROCKY MOUNTAINS: II. OBSERVATIONS OVER THE BRIDGER RANGE, MONTANA,
Bureau of Reclamation, Denver, CO.
A. B. Super, and J. A. Heimbach.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 10, p 1152-1165, October 1988. 3 fig, 3 tab, 19 ref. NSF Contract ATM 8414143.

Descriptors: *Micrometeorology, *Cloud seeding, *Silver iodide, *Weather modification, *Rocky Mountains, *Montana, Aircraft, Supercooled liquid water, Clouds, Plumes, Ice, Precipitation rate, Ice formation, Artificial precipitation, Sampling, Air temperature, Statistical models, Snow, Nucleation.

Six aircraft sampling flights made in clouds over the target area of an earlier randomized exploratory cloud seeding experiment are described. One of the two silver iodide generator sites used in an earlier experiment was operated well up the west (windward) slope of the north-south oriented Main Ridge. Crosswind aircraft sampling was done to within 300 m above the secondary ridge target area about 17 km downwind of the silver iodide generator. The silver iodide plume was detected over the target area on each of the six missions and was generally 5 to 8 km wide. Three of the missions detected supercooled liquid water in the region of the silver iodide plume. The ice particle concentration averaged about an order of magni-

tude higher in the seeded zone in these cases, and the estimated precipitation rate was greater, as compared with crosswind control zones. Most seeded ice particles were small hexagonal plates, appropriate for the prevailing temperatures and moisture conditions. The silver iodide generator was deliberately turned off in one of the experiments, and the seeding effects decreased with time beginning about one hour later. The other three missions sampled negligible supercooled liquid water in the seeded region over the target area. Observations did not indicate detectable changes in the ice particle concentrations, sizes or habits. The results of this series of physical experiments are in agreement with statistical suggestions from an earlier randomized experiment. It appears that seeding the stable orographic clouds over the Bridger Range sometimes caused marked increases in ice particle concentration, presumably leading to more surface snowfall. The physical observations indicate that enhanced ice particle concentration was largely dependent upon the availability of supercooled liquid water when temperatures were cold enough for silver iodide nucleation. (See also W89-05999 and W89-06001) (Author's abstract)
W89-06000

MICROPHYSICAL EFFECTS OF WINTERTIME CLOUD SEEDING WITH SILVER IODIDE OVER THE ROCKY MOUNTAINS: III. OBSERVATIONS OVER THE GRAND MESA, COLORADO,
Bureau of Reclamation, Montrose, CO.
A. B. Super, and B. A. Boe.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 10, p 1166-1182, October 1988. 11 fig, 2 tab, 9 ref.

Descriptors: *Micrometeorology, *Cloud seeding, *Silver iodide, *Weather modification, *Rocky Mountains, *Colorado, Aircraft, Supercooled liquid water, Plumes, Precipitation rate, Snow, Ice.

Several airborne and ground-based silver iodide seeding experiments conducted over the Grand Mesa (Colorado), during a three-day period of northerly flow and shallow orographic cloud, are described. While little natural snowfall was observed during these experiments, supercooled liquid water formed over the windward slopes and evaporated to the lee of the mesa for many hours. Seeding-induced microphysical changes coincident with the silver iodide plumes were found in all eight experiments (including two that employed ground-based seeding) by aircraft sampling about 500 m above the mesa top. Precipitation rates estimated from ice particle images at flight levels suggested increases within seeded volumes in all but one ground-based seeding experiment that coincided with the passage of silver iodide plumes aloft. Surface observations were not possible during the other ground-based seeding experiment, but some increase in snowfall is thought probable. Three aircraft seeding experiments failed to show surface snowfall increases, and reasons for this probably relate to the insufficient residence time of the silver iodide and resulting crystals in supercooled liquid water cloud. (See also W89-05999 and W89-06000) (Author's abstract)
W89-06001

MULTIOBJECTIVE, DISCRETE SYSTEM REPRESENTATION OF RANGELAND WATERSHEDS,
Maricopa County Flood Control District, Phoenix, AZ.
For primary bibliographic entry see Field 6A.
W89-06059

CLIMATE-BASED REPRESENTATIONS OF SUMMER RAINFALL IN ILLINOIS,
Illinois State Water Survey Div., Champaign. Climatology and Meteorology Section.
S. A. Changnon.
Journal of Climate JLCLEL, Vol. 1, No. 10, p 1041-1046, October 1988. 3 tab, 7 ref. NOAA Cooperative Agreement NA87RAH06051.

Descriptors: *Weather data, *Climatic data, *Climatology, *Climate, *Rainfall, *Illinois, *Meteorological data collection, Weather modification, Models, Crop yield, Stochastic process.

Historical (1901-1985) summer (June-August) rainfall data in central Illinois were used to construct three typical rain conditions: one representing the typical dry summer (based on the driest 20% of the summers of the past 85 years), a typical wet summer (from the 20% wettest), and the near-average summer rainfall conditions (the 20% nearest the long-term average). Monthly rain totals for each type were established first, then daily rain frequencies were used to define all individual rain day amounts, and historical rain-day amounts by date were used to assign rain days to dates throughout the three types of summers. In-day conditions relating to rainfall rates time of rain, and durations were constructed for each day of rain. The resulting three summer rainfall conditions are being used to guide applications of water onto agricultural test plots (protected from natural rains) to measure crop yield effects from weather modification but the approach and system could serve other applications such as assessing the effects of potential future climate change on crop production. (Author's abstract)
W89-06467

WORKSHOP DESIGN FOR RAINWATER ROOF CATCHMENT SYSTEMS: A TRAINING GUIDE,
Water and Sanitation for Health Project, Arlington, VA.
D. Edwards, K. Keller, and D. Yohalem.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 27, June 1984. 409p. WASH Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Training *Handbooks, *Roof catchment, *Domestic water, *Rain, *Water supply development, Developing countries, Water resources management, Water storage, Costs, Project planning, Drains, Cisterns, Maintenance, Public participation.

This training guide provides systematic skill development for training local project promoters in the steps and techniques necessary for a project in rainwater roof catchment systems. It provides training in setting up systems intended for either dry or wet areas. The guide is a response to the need for water supply in developing countries where roof catchment for drinking and domestic use is feasible and often the only low-cost alternative. At the end of the workshop, participants should be able to: plan and develop a rainwater roof catchment project; determine the feasibility of a rooftop catchment program in light of local rainfall patterns; assess a community's willingness and ability to support a rooftop catchment system; conduct an inventory of local skills, materials, and techniques which can be used in rooftop catchment; choose the most appropriate technologies for tank and gutter construction; calculate an optimum size for a storage tank; mix and prepare cement and mortar; design and plan a rainwater catchment system using all of the steps and procedures necessary for detailing and ordering construction materials; design and construct a roof catchment and filtration system for thatch roofs; manage the ordering of material and labor necessary for constructing a rainwater roof catchment system; build a small household storage tank and a large cistern tank; develop strategies for involving communities in the construction of the system; develop a monitoring and maintenance plan for the system which the community can use and implement; construct, connect and hang gutters for the system; and, develop action plans for promoting rainwater roof catchment in their project areas. (Lantz-PTT)
W89-06602

ICE AND SEDIMENT FACTORS IN THE SELECTION OF INUIT WATER SUPPLIES FROM LENTIC SOURCES,
Wisconsin Univ.-Milwaukee. Dept. of Geography.
For primary bibliographic entry see Field 5F.
W89-06935

DEVELOPMENT OF RESERVOIR OPERATING RULES WITH WATER QUALITY OBJECTIVES,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-06942

3C. Use Of Water Of Impaired Quality

TRICKLE IRRIGATION OF COTTON WITH TREATED SEWAGE EFFLUENT,
Agricultural Research Inst., Nicosia (Cyprus).
For primary bibliographic entry see Field 5E.
W89-05929

LONG TERM EFFECTS OF VARYING LEVELS OF BOD OF IRRIGATION WATERS ON CROPS,
National Environmental Engineering Research Inst., Nagpur (India).
V. J. Nashikkar, and G. B. Shende.
Resources, Conservation and Recycling, Vol. 1, No. 2, p 131-136, June 1988. 1 fig, 4 tab, 8 ref.

Descriptors: *Irrigation, *Impaired water use, *Biological oxygen demand, *Wastewater irrigation, *Wastewater disposal, *Crop production, Nitrification, Land disposal, Fertilizers, Nutrients, Nitrogen, Potassium, Phosphorus, Air temperature, Plant growth.

Systematic studies were carried out to study the response of a wide variety of crops to the varying levels of biological oxygen demand (BOD) of wastewaters used for irrigation and their effects on soil nitrification. The growth and yield responses of 14 crops were tested in a randomized plot design using different irrigation waters representing different BOD levels. Results showed that irrigation with sewage effluent having a BOD range of 50-1000 mg/L resulted generally in higher yields of crops as compared to plain water irrigation and application of recommended NPK. A major exception to this general observation was the yield response of two leguminous crops of moong and pea where the yields were significantly lower under irrigation with wastewater having a BOD level of 400 and 1000 mg/L. The winter crops of cabbage, cauliflower, wheat, potato, winter brinjal and early summer lady's finger showed optimum growth and yield response at 150 mg/L BOD level, exerted by settled sewage. The yield levels of the summer crops of maize, lady's finger, cotton and brinjal under irrigation with even 1000 mg/L BOD sewage were not significantly less than with 150 mg/L and 400 mg/L BOD sewage. Studies on the uptake of nutrients by moong, cabbage and maize showed that up to a BOD level of 150 mg/L, the uptake of N, P2O5 and K2O increased significantly in comparison with the control. This increase was attributable to the nutrients supplied through wastewater irrigation. Although no proportionate increase in the uptake of nutrients in relation to the high rate of supply at 1000 mg/L was observed, there was no adverse effect of the higher level of BOD of sewage used for irrigation on the physiological processes involved in the uptake of nutrients in the case of those crops. It was concluded that the response of crops to the varying levels of BOD of irrigation water is influenced mainly by the growing season temperature. The higher the temperature, the higher is the rate of decomposition of organic matter, exercising oxygen demand with less deleterious effect on plant processes and growth. (Geiger-PTT)
W89-06180

INTERMITTENT EVAPORATION, MOISTURE DISTRIBUTION, AND SALT REDISTRIBUTION THROUGH SALINE-SODIC CLAY SOIL AS AFFECTED BY IRRIGATION FREQUENCY AND QUANTITY,
Khartoum Univ. (Sudan). Dept. of Agricultural Engineering and Soil Science.
For primary bibliographic entry see Field 2D.

W89-06484

TREATMENT AND USE OF SEWAGE EFFLUENT FOR IRRIGATION.
For primary bibliographic entry see Field 5D.
W89-06801

BACKGROUND TO TREATMENT AND USE OF SEWAGE EFFLUENT,
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
For primary bibliographic entry see Field 5D.
W89-06802

GUIDELINES FOR WASTEWATER REUSE IN AGRICULTURE,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
M. B. Pescod, and U. Alka.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 21-37, 7 tab, 5 fig, 28 ref.

Descriptors: *Agriculture, *Standards, *Wastewater irrigation, *Trickle irrigation, *Water reuse, *Wastewater disposal, *Land disposal, *Irrigation effects, *Wastewater treatment, Path of pollutants, Fate of pollutants, Pathogens, Wastewater pollution, Pathogenic bacteria, Metals, Salts, Arid climates, Arid lands, Israel, Costs, Risks.

In assessing the hazards associated with effluent reuse, the various pathways for the dissemination of undesirable pollutants have been examined. Factors that affect pathogen survival include the number and type of organisms, soil organic matter content, temperature, humidity, pH, amount of rainfall, amount of sunlight, protection provided by foliage, and competitive microbial flora. The survival of pathogens in the soil has been reported to vary from a few hours to several months. In arid zones with high temperatures and low humidity resulting in high rates of evaporation, salt deposition from the applied water tends to accumulate in the soil profile. Due to these problems reuse application requires emphasis on the removal of selected physicochemical and biological constituents to user-specific non-adverse levels. Of the irrigation techniques available, trickle irrigation seems to be the most promising method from both the health and water-conservation standpoints and is now being used in a number of countries, especially in Israel. Trickle irrigation has proved to be efficient in arid areas because it reduces water consumption and increases the yield of crops. The main advantage is the contact between the effluent and the crops is less than for other irrigation techniques. The main disadvantages are a relatively high investment cost, a risk of clogging, and a risk of damage. (See also W89-06801) (White-Reimer-PTT)
W89-06803

QUALITY CRITERIA IN USING SEWAGE EFFLUENT FOR CROP PRODUCTION,
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
A. Kandiah.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 38-51, 6 tab, 1 fig, 5 ref.

Descriptors: *Water quality standards, *Crop production, *Wastewater irrigation, *Irrigation, *Wastewater disposal, *Water reuse, *Land disposal, *Irrigation effects, *Irrigation practices, Toxicity, Salinity, Forests, Forages, Standards, Public health, Hawaii, United Nations, Irrigation water, Biological properties, Wastewater treatment.

When considering the use of effluents for irrigation, their microbial and biochemical properties have to be evaluated. The key consideration in the successful reuse of wastewater is the economical removal of substances that are detrimental to the proposed wastewater use. Although irrigation with treated wastewater can provide benefits, some of the major concerns are; (a) health hazards; (b) salinity build-up; and (c) toxicity hazards. Recent guidelines for evaluation of water quality for agriculture published by the FAO, which are presented, use four problem categories (salinity, infiltration, toxicity, and miscellaneous) for the evaluation of conventional sources of irrigation water. Water may be classified into one of three catagories: no restriction; slight to moderate restriction; and severe restriction for use. In using sewage effluents, crop selection should also be considered from the point of view of public health hazards. Forest crops offer the best opportunity for effluent irrigation with the least risk to public health. Effluent irrigation of industrial crops not intended for human or animal consumption also has a low risk to public health. Forage crops are more suited to sewage irrigation than vegetables which are likely to be eaten raw by people. Hawaii has developed the most comprehensive set of principles and guidelines for sewage effluent irrigation in the United States. (See also W89-06801) (White-Reimer-PTT)
W89-06804

HEALTH ASPECTS OF REUSE OF TREATED WASTEWATER FOR IRRIGATION,
World Health Organization, Alexandria (Egypt). Regional Office for the Eastern Mediterranean.
For primary bibliographic entry see Field 5F.
W89-06805

ENVIRONMENTAL HAZARDS OF SEWAGE AND INDUSTRIAL EFFLUENTS ON IRRIGATED FARMLANDS IN JAPAN,
Tsukuba Univ. (Japan). Inst. of Applied Biochemistry.
For primary bibliographic entry see Field 5E.
W89-06806

WASTE STABILIZATION PONDS: THE PRODUCTION OF HIGH QUALITY EFFLUENTS FOR CROP IRRIGATION,
Leeds Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-06807

SOIL-AQUIFER TREATMENT AND REUSE OF SEWAGE EFFLUENT: A NEW APPROACH TO SANITATION,
BURGEAP S.A., Paris (France).
For primary bibliographic entry see Field 5D.
W89-06811

USE OF BIOLOGICALLY TREATED WASTEWATER TOGETHER WITH EXCESS SLUDGE FOR IRRIGATION,
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Stadtbauwesen.
R. Kayser.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 175-184, 5 tab, 3 fig.

Descriptors: *Wastewater treatment, *Wastewater irrigation, *Wastewater disposal, *Wastewater renovation, *Biological wastewater treatment, *Water reuse, *Reclaimed water, *Land disposal, *Sludge disposal, *Sludge utilization, Sprinkler irrigation, Costs, Heavy metals, Nutrients, Crop yield, Pathogens, Germany, Cost analysis.

The experience gained from the Braunschweig (40,000 cu m/d) and the Wolfsburg (16,000 cu m/d) wastewater irrigation systems in Germany is discussed. The wastewater is distributed by a subsurface pressure pipe network with a portable pipe system for sprinkling. For economic reasons a pumping station was installed for each 500-1000 hectares irrigated. The intermittent operation of sprinkling made balancing tanks necessary which were built in conjunction with the pumping stations and also serve as settling tanks. Drum-coiled pipe-irrigation machines were added to reduce operational costs associated with manually moving the pipes. To eliminate odor problems, easily biodegradable organics were removed and the sludge was mixed with the biologically treated water and used for irrigation. No increase in heavy metals has been reported in the Wolfsburg soils, but in Braunschweig levels are higher, possibly because of higher background concentrations. Phosphorus in the soil has increased since the start of wastewater irrigation and about half the nitrogen is contained in the excess sludge, most of it organic. It was concluded that wastewater irrigation is a very effective means of wastewater treatment; achieving almost tertiary effluent quality regardless of the degree of pretreatment. It is also cost effective for irrigation needs. (See also W89-06801) (White-Reimer-PTT)
W89-06813

STATUS OF WASTEWATER TREATMENT AND AGRICULTURAL REUSE WITH SPECIAL REFERENCE TO INDIAN EXPERIENCE AND RESEARCH AND DEVELOPMENT NEEDS,
National Environmental Engineering Research Inst., Nagpur (India).
For primary bibliographic entry see Field 5D.
W89-06814

EGYPTIAN EXPERIENCE IN THE TREATMENT AND USE OF SEWAGE AND SLUDGE IN AGRICULTURE,
Alexandria Univ. (Egypt).
For primary bibliographic entry see Field 5D.
W89-06815

TREATMENT AND USE OF SEWAGE EFFLUENT FOR AGRICULTURE IN CYPRUS: IMMEDIATE PROSPECTS,
For primary bibliographic entry see Field 5D.
W89-06816

ONGOING RESEARCH ON THE USE OF TREATED SEWAGE EFFLUENT FOR IRRIGATING INDUSTRIAL AND FODDER CROPS,
Agricultural Research Inst., Nicosia (Cyprus).
I. Papadopoulos, and Y. Stylianou.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 240-248, 6 tab, 14 ref.

Descriptors: *Wastewater treatment, *Wastewater irrigation, *Trickle irrigation, *Water reuse, *Reclaimed water, Crop production, Irrigation effects, Soil analysis, Soil contamination, Nutrients, Heavy metals, Crop yield, Cotton, Nitrogen, Salts, Cyprus, Irrigation water, Public health, Clogging.

A long-term irrigation experiment was initiated in 1984 on a calcaric lithosol soil (35% clay, 28% sand, 26% CaCO3) to study the influence of treated municipal effluent on the soil and on N-nutrition, growth and yield of drip-irrigated crops. Two sources of irrigation water were used, secondary-treated sewage effluent and fresh well water, and four concentrations of nitrogen were applied continually as ammonium nitrate in the irrigation water. There were no heavy metals or organic toxicants at concentration levels sufficient to present a problem. Soil samples were taken from each main plot prior to the start of the experiment and semiannually below the tricklers during the experiment. Results indicated nitrogen naturally occurring in the effluent is a valuable nutrient source; however, an excess poses a potential groundwater pollution hazard. Less salt build-up was observed using sewage effluent than for well water. Crop yields were higher for the effluent treated plots. There were no adverse health effects or unacceptable odor associated with the irrigation. However, emitter clogging caused by chemical and biological build-up in the minute water passageways was a serious problem. (See also W89-06801) (White-Reimer-PTT)
W89-06817

MEXICAN EXPERIENCE IN USING SEWAGE EFFLUENT FOR LARGE SCALE IRRIGATION,
Ministry of Agriculture and Water Resources, Mexico City.

N. S. Duron.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 249-257, 5 tab, 8 ref.

Descriptors: *Wastewater irrigation, Wastewater disposal, *Water reuse, *Reclaimed water, *Irrigation effects, *Land disposal, *Mexico, Irrigation practices, Pathogens, Public health, Nutrients, Heavy metals, Salts, Soil contamination, Crop production, Public participation, Crop yield, Economic aspects.

Sewage effluent and clean water from local dams are used for irrigation in the Mezquital Valley. Although toxic elements are accumulating, it is believed that a dynamic equilibrium has been reached in the soils, and the majority of the regional crops and animals are tolerant or semitolerant to the irrigation water. Parasitic and pathogenic microorganisms are present in the water and soil in the region, but have numerous origins in addition to sewage effluent. Therefore, the advantages of sewage irrigation in increased crop production and improved standard of living are believed to be of greater importance to the local farmers. In order to be effective, programs to improve sanitary conditions need the support of the people. The yields of the majority of crops harvested in the agricultural year are now greater than the yield obtained 10 years ago, except for pasture. It is believed that the high content of organic matter and plant nutrients in the sewage have improved the physical and chemical properties of the shallow soils in the irrigation district. The improved economic conditions in the region as a result of the irrigation are an important aspect in keeping the farmers on the land. The most serious problems are related to pathogenic microorganisms, heavy metal contamination and the salinity hazard. (See also W89-06801) (White-Reimer-PTT)
W89-06818

PLANNING AND STRATEGY OF WASTEWATER AND WASTEWATER REUSE IN JORDAN,
Water Authority of Jordan, Amman. Treatment Plants Dept.
S. El-Salem, and M. Talhouni.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 258-272, 9 tab, 2 fig, 12 ref.

Descriptors: *Wastewater irrigation, *Wastewater treatment, Wastewater disposal, *Reclaimed water, *Wastewater renovation, *Water reuse, *Irrigation, *Irrigation programs, *Irrigation practices, *Jordan, *Multiobjective planning, Crop production, Crop yield, Alfalfa, Barley, Future planning, Water pollution control, Economic aspects.

It is evident from the information presented on available water resources, sanitation services, and population projections, that the reuse of treated wastewater in Jordan will be an important element of the government economic, agricultural and water policy. By reusing this water from the various cities and areas, the agricultural land area will be increased and have a better geographical distribution. As a result of using treated wastewater for irrigation, a large quantity of potable water can be saved. Additionally, ground and surface water can be protected against pollution due to extensive treatment and disinfection processes. By using wastewater, it is projected that 5816 tons of barley and 32,345 tons of alfalfa can be produced using the land only once for each crop. The value of these crops at 1985 prices is nearly equal to the value of 1983 imports of concentrated materials used for forage preparation. (See also W89-06801) (White-Reimer-PTT)
W89-06819

PLANS FOR REUSE OF WASTEWATER EFFLUENT IN AGRICULTURE AND INDUSTRY IN THE KINGDOM OF SAUDI ARABIA,
Ministry of Agriculture and Water, Riyadh (Saudi Arabia). Water Research and Studies Div.
M. S. Kalthem, and A. M. Jamaan.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 273-283, 8 tab, 3 fig, 15 ref.

Descriptors: *Wastewater irrigation, *Water reuse, *Industrial water, *Future planning, *Wastewater disposal, *Wastewater treatment, *Wastewater renovation, *Reclaimed water, *Irrigation water, *Saudi Arabia, Agriculture, Planning, Wastewater pollution, Water demand, Water quality, Land disposal, Sludge utilization, Advanced wastewater treatment.

Although about 674 M cu m/y of reclaimed wastewater will be available by the year 2000, this is a relatively small quantity compared with the water demand from agriculture and industry. In order to reuse wastewater, treatment is necessary in order to protect the environment and public health, prevent nuisance conditions and damage to crops and soil, and to protect water resources from pollution. The quality of the reused water depends on the nature of the raw water and the treatment process. Wastewater is currently being used in agriculture in Riyadh, Madinah, and the Qassim region. The Ministry of Agriculture and Water is conducting research to develop guidelines for the proper application of sludge on land. Preliminary results indicate sludge should be applied at least one month before planting, along with supplemental nitrogen fertilizer. Approximately 10% of the available reclaimed wastewater will be utilized by industry. Additional advanced treatment necessary for industrial use is usually provided by the individual industries. (See also W89-06801) (White-Reimer-PTT)
W89-06820

TREATED SEWAGE EFFLUENT FOR IRRIGATION IN KUWAIT.
Kuwait Agriculture Affairs and Fish Resources Authority, Safat.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 284-288. Append.

Descriptors: *Wastewater irrigation, *Wastewater disposal, *Water reuse, *Wastewater renovation, *Wastewater treatment, *Kuwait, Wastewater facilities, Sludge conditioning, Sludge disposal, Agriculture, Crop production, Pathogens, Reclaimed water, Land disposal, Irrigation requirements, Tertiary wastewater treatment, Irrigation programs, Cadmium, Bacteria, Human diseases.

The availability of irrigation water at a reasonable cost is one of the most important factors affecting the development and expansion of agriculture in Kuwait. Three sewage treatment plants have been constructed; one at Ardiya, one at the coastal villages, and one at Jahra, in order to use the treated effluent for irrigation. The treated effluent is further upgraded using tertiary treatment consisting of chlorination, rapid sand filtration and final chlorination. The sludge is processed and used as a soil conditioner and fertilizer. The highest priority is given to the development of irrigated agriculture with an ultimate project design providing for the development of 2700 ha of intensive agriculture and 9000 ha of environmental forestry. Crops being irrigated with treated effluent on experimental farms include fodder plants, field crops, fruit trees, and vegetables. Monitoring is done daily for heavy metals and bacteria. Cadmium is the only heavy metal that might cause a health problem in food grown on treated sewage effluent, and it will be measured in crops and in the kidneys of foraging animals. Agricultural workers are medically examined and given periodic vaccination, and no outbreaks of infectious diseases have occurred since the project began. (See also W89-06801) (White-Reimer-PTT)
W89-06821

USE OF TREATED SEWAGE EFFLUENT FOR IRRIGATION: CASE STUDY FROM KUWAIT,
Cobham Resource Consultants, Oxford (England).
R. O. Cobham, and P. R. Johnson.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 289-305, 8 tab, 3 fig, 9 ref.

Descriptors: *Wastewater treatment, *Wastewater irrigation, *Irrigation, *Wastewater disposal, *Water reuse, *Reclaimed water, *Wastewater renovation, *Land disposal, *Irrigation programs, *Irrigation practices, *Irrigation water, *Kuwait, Agriculture, Planning, Comprehensive planning, Project planning, Regional development, Multiobjective planning, Crop yield, Public health, Irrigation efficiency, Case studies.

The first major sewage treatment works were commissioned at Ardiyah and the treated effluent distributed to the experimental farm at Omariyah. Crop yields were compared using potable water, brackish water, and treated effluent. Public health considerations restricted the options for water reuse to: (1) the production of 'safe' crops (those requiring cooking or with edible parts not receiving irrigation prior to harvesting); (2) commercial afforestation for fuel and charcoal; and (3) green belts of trees and shrubs adjacent to highways. Attention was focused on irrigation methods based on their relative efficiencies as well as on the capital expenditures and staffing implications. Full-scale operation of the project began in late 1984, and while physical progress has largely matched the expectations, many of the organizational and management arrangements still remain to be finalized. As with most major development projects the creation of appropriate management, monitoring and public relations procedures is as important as the construction works. A review of key considerations concerning public health risks, the choice of single-use or multiple-use strategies, and reuse strategy evaluation criteria is presented. (See also W89-06801) (White-Reimer-PTT)
W89-06822

IRRIGATION OF DAMASCUS PLAIN (THE GHOUTA) WITH POLLUTED WATER FROM THE RIVER BARADA,
Damascus Univ. (Syria). Coll. of Engineering.
M. N. Al-Rifai.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 306-329, 14 tab, 9 fig, 10 ref.

Descriptors: *Syria, *Impaired water use, *Irrigation, *Wastewater disposal, *Water reuse, *Reclaimed water, *Wastewater pollution, *Wastewater renovation, *Wastewater treatment, *Land disposal, *Irrigation programs, *Irrigation effects, Pathogens, Salts, Coliforms, Heavy metals, Biochemical oxygen demand, Chlorides, Wastewater irrigation, Irrigation practices, Projections, Water quality, Public health, Regional development, Wastewater treatment facilities, Pumping plants.

Municipal and industrial wastewaters have been reused for irrigation on the plain of Damascus, the Ghouta, for a long time. In 1985, about 80 M cu m of domestic wastewater was being reused annually for irrigation and for groundwater replenishment in the Ghouta area. It is anticipated that this figure will be more than 125 M cu m in the year 2001. The main disadvantage of the wastewater reuse is the bacteriological count, the BOD concentrations, the salinity, chloride, heavy metals, and other phytotoxins in the irrigation water. This pollution seriously affects the water quality and creates health and environmental hazards. The groundwater has dangerously high coliform levels that exceed World Health Organization guidelines. Despite the fact that water is the limiting factor in new land development, it was concluded that an adequate sewerage system and treatment plant should be implemented before reusing municipal and industrial wastewater for irrigation and groundwater replenishment, especially in arid or semiarid zones such as the Near East region, the Gulf States and Arab Peninsula, and many other Arab countries. A treatment plant using the activated sludge process is planned at Ain Terma, east of Damascus City. Pumping stations and pumping mains will be used to maintain traditional irrigation flows in the Barada River tributaries. (See also W89-06801) (White-Reimer-PTT)
W89-06823

Group 3C—Use Of Water Of Impaired Quality

STUDY OF METHODOLOGIES REGARDING THE USE OF TREATED WASTEWATER FOR IRRIGATION IN PORTUGAL,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
M. H. F. Marecos do Monte.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 330-343, 14 tab, 3 fig, 9 ref.

Descriptors: *Wastewater irrigation, *Irrigation water, Land disposal, *Wastewater treatment, *Water reuse, *Irrigation practices, *Portugal, Agriculture, Crop production, Maize, Sorghum, Sunflowers, Pathogens, Soil profiles, Soil analysis, Salts, Reclaimed water, Experimental design, Salt tolerance, Monitoring, Comparison studies.

Wastewater treated by primary sedimentation and high rate trickling filters was used for irrigation experiments on maize, sorghum and sunflowers. Soil profiles were studied emphasizing depth, color, moisture content, texture, organic matter content, structure, compaction, porosity, carbonate and general chemical composition; the climate was characterized based on data for the last 30 years; and a field layout was designed to avoid the risk of cross contamination between plots irrigated with different wastewaters. Although the natural water was suitable for the irrigation of any crop, the salinity levels of the effluents of the primary and final settling tanks were such that they should be used only for fairly salt tolerant crops. The monitoring program included physicochemical and microbiological parameters of the wastewaters, soil and crops; and measurements of crop productivity. Drinking water, primary settling tank effluent, and final settling tank effluent were used for plot irrigation, and the plants were harvested from the subplots and weighed to determine productivity. (See also W89-06801) (White-Reimer-PTT)
W89-06824

TREATMENT AND USE OF SEWAGE EFFLUENT FOR IRRIGATION IN WESTERN ASIA,
Economic Commission for Western Asia, Baghdad (Iraq). Natural Resources, Science and Technology Div.
For primary bibliographic entry see Field 5D.
W89-06826

ALFALFA WATER-PRODUCTION FUNCTIONS UNDER CONDITIONS OF DEFICIT IRRIGATION WITH SALINE WATER,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
K. S. Pennington.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704236. Ph.D. Dissertation, 1986. 104p, 16 fig, 11 tab, 57 ref, 4 append.

Descriptors: *Saline water, *Saline water irrigation, *Irrigation water, *Surface irrigation, *Crop yield, *Alfalfa, Greenhouses, Saline soils, Leaching, Osmotic pressure, Plant growth, Evapotranspiration, Irrigation efficiency.

Two experiments were run sequentially in soil columns in a greenhouse to determine the shape of the yield response function relating crop yield to the total amount of saline irrigation water applied. Alfalfa was grown for one year in 0.2 diameter by 1.2 m high soil columns. The columns were irrigated with an electrical conductivity (ECi) solution of 4 ds/m or 8 ds/m. Both solutions were prepared by adding equivalent amounts of sodium chloride and calcium chloride to distilled water. The amounts of irrigation water applied in both experiments were 110%, 100%, 75%, 50% and 25% of the measured evapotranspiration. The crop-saline water production functions for both experiments were linear. Leaching fractions in experiment 1 were 9, 9, 6, 5, and 5% for treatments 1-5; experiment 2 leaching fractions were 23, 25, 18, 15, and 17%. The lowest rootzone soil water osmotic potentials achieved by the end of experiment 1 for treatments 1-5 were -19, -20, -18, -26, and -24 bars. Corresponding treatment values achieved by the end of experiment 2 were -18, -22, -28, -31, and -45 bars. (Cremmins-AEPCO)
W89-06959

MANAGING SALINE WASTE WATER FOR CROP PRODUCTION AND MINIMUM LEACHING,
California Univ., Riverside. Graduate Program in Soil Science.
F. F. Ernst.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8613848. Ph.D. Dissertation, 1986. 286p, 35 fig, 73 ref, 3 append.

Descriptors: *Saline water, *Saline water irrigation, *Irrigation water, *Sprinkler irrigation, *Wastewater irrigation, *Crop yield, Sorghum, Wheat, Grain crops, Leaching, Plant growth, Evapotranspiration, Irrigation efficiency.

Double-cropped sorghum and wheat were irrigated with undiluted saline wastewater to determine if grain yields can be significantly increased by applying nonsaline water at a critical growth stage. Irrigation uniformity was maximized and leaching was minimized to encourage precipitation and salt storage in the soil while maintaining adequate grain production. The experiment was conducted on a Tujunga loamy sand over three years using conventional cultural practices and sprinkler irrigation with either nonsaline water or with saline wastewater rich in calcium sulfate. Treatment with nonsaline water during germination and reproductive growth and saline water during vegetative and grainfill growth produced higher grain yields than other saline irrigated treatments. Grain production equalled the yield of the nonsaline treatment for the first two years. But, in the third year when soil salinity levels were higher, grain production decreased to levels approaching the other saline treatment. Total plant height and sorghum grain yield were poorly correlated in the first two years but highly correlated in the third year when soil salinity levels were high. Mean soil electrical conductivity and chloride concentration from surface to 0.25 m depth for a combination of preplant, boot, and grainfill sampling dates were most strongly correlated with sorghum grain yields over all three years. (Cremmins-AEPCO)
W89-06963

3D. Conservation In Domestic and Municipal Use

WASTEWATER RECYCLING AND WATER CONSERVATION IN COMMERCIAL AND PUBLIC FACILITIES: CASE HISTORIES,
For primary bibliographic entry see Field 5D.
W89-05867

POROUS PIPE RETURNS AS MUNICIPAL WATERING ALTERNATIVE,
Dallas Dept. of Public Works, TX.
For primary bibliographic entry see Field 3F.
W89-06551

EFFECT OF CONSERVATION PROGRAMS ON THE QUALITY OF URBAN LAWNS,
Colorado Univ. at Boulder. Dept. of Civil, Environmental, and Architectural Engineering.
A. S. Winje, and J. E. Flack.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 160643/AS, price codes: A05 in paper copy, A01 in microfiche. Colorado Water Resources Research Institute, Fort Collins, Completion Report No. 142, September 1986. 71p, 6 fig, 14 tab, 31 ref. USGS contract 14-08-0001-G1006. USGS project G1006-07.

Descriptors: *Water conservation, *Urban planning, *Water requirements, *Lawns, Water supply, Colorado, Front Range, Prices.

Growing populations and a limited water supply have made water conservation a necessary part of municipal supply programs for most Front Range Colorado cities. This research was conducted to determine if intensity of conservation programs has an effect on the quality of urban lawns. Three levels of intensity (which include water price) were identified: aggressive; moderate; and passive. Lawn quality was measured on a random sample of 209 lawns in seven northern Colorado cities: Greeley; Fort Collins; Broomfield; Longmont; Boulder; Aurora; and Lafayette. Color reference cards were used to determine lawn quality by the relative greenness of the lawn. Data were collected for each city during the summer seasons of 1985 and 1986. The statistical tests and other observations suggest that higher conservation intensity (including water price) results in lower lawn quality. The lowest-quality lawns were associated with cities using aggressive conservation intensity. There was little difference in lawn quality between the two lower levels of conservation intensity (moderate and passive). However, lawn quality was acceptable even with a moderate level of conservation intensity and price. (USGS)
W89-06905

APPLICATION OF ZONAL PRICING TO A METROPOLITAN WATER UTILITY,
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 6C.
W89-06917

FINANCIAL STABILITY OF PUBLICLY OWNED WATER SYSTEMS IN SOUTH CAROLINA,
Clemson Univ., SC. Graduate School
For primary bibliographic entry see Field 6C.
W89-06934

SEASONAL PRICING OF MUNICIPAL WATER SUPPLIES WITH MULTIPLE STOCHASTIC INFLOWS AND STORAGE,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 6C.
W89-06941

DAILY URBAN WATER USE ANALYSIS AND FORECASTING,
Texas Univ. at Austin. Graduate School.
For primary bibliographic entry see Field 6D.
W89-06975

3F. Conservation In Agriculture

EVALUATION OF FACTORS CONTRIBUTING TO DIURNAL CHANGES IN O2 CONCENTRATIONS IN FLOODWATER OF DEEPWATER RICE FIELDS,
Western Australia Univ., Nedlands. Inst. of Agriculture.
For primary bibliographic entry see Field 2H.
W89-05812

TRICKLE IRRIGATION OF COTTON WITH TREATED SEWAGE EFFLUENT,
Agricultural Research Inst., Nicosia (Cyprus).
For primary bibliographic entry see Field 5E.
W89-05929

EFFECT OF TRAJECTORY ANGLE ON PERFORMANCE OF SPRINKLERS IN WIND,
Tennessee Univ., Knoxville. Dept. of Agricultural Engineering.
R. D. von Bernuth.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 579-587, November 1988. 9 fig, 10 ref.

Descriptors: *Sprinkers, *Irrigation efficiency, *Wind, *Sprinkler irrigation, *Model studies, Computer models, Trajectory angle, Performance evaluation, Fluid drops, Wind velocity.

The effect of changing the trajectory angle of a medium-sized irrigation sprinkler operating in windy conditions has been studied using a computer-simulation model. The model, which has been

verified both in still air and under windy conditions, shows that the trajectory angle that maximizes distance of throw is a function of the wind velocity and varies from 29 degrees in still air to less than 5 degrees in winds greater than 8 m/s. The advantage gained from trajectory angles greater than 25 degrees in still air is quickly overcome by the disadvantages in range reduction and drift in relatively light winds. When choosing the appropriate trajectory angle, consideration should be given to the drop-size distribution and the wind velocity. This is because both wind drift and range depend upon drop size and trajectory angle. (Author's abstract)
W89-05957

TIME SOLUTION OF KINEMATIC-WAVE MODEL WITH STOCHASTIC INFILTRATION,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. Rayej, and W. W. Wallender.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 605-621, November 1988. 9 fig, 1 tab, 18 ref, append.

Descriptors: *Model studies, *Stochastic hydrology, *Infiltration, *Kinematic wave theory, Wetting, Runoff, Recession, Furrow irrigation, Soil properties, Mathematical equations.

A kinematic-wave furrow model with spatial variability of infiltration is developed to solve directly for advance times. In addition, infiltration varies with wetted perimeter. During advance, the system of nonlinear equations is solved implicitly for flow area and time step using the double-sweep technique. During runoff and recession, flow area is found explicitly cell-by-cell at each specified time step. Including spatially varying infiltration as well as wetted perimeter effects improves furrow simulation when compared with the results of previous kinematic-wave models. The present model can be used as a tool in design and evaluation of furrow irrigation systems under uniform and nonuniform soil conditions. (Author's abstract)
W89-05959

ON-FARM APPLICATION SYSTEM DESIGN AND PROJECT-SCALE WATER MANAGEMENT,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
S. I. Sritharan, W. Clyma, and E. V. Richardson.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 622-643, November 1988. 3 fig, 10 tab, 17 ref.

Descriptors: *Irrigation design, *Farms, *Systems analysis, *Project planning, *Water management, Water supply, Irrigation efficiency, Optimization, Irrigation requirements, Flow characteristics, Available water.

Project-scale optimal on-farm designs considering total water availability as well as the variability in the on-farm parameters are obtained using a two-stage programming approach in a mode of maximizing the net benefits from the project area. This provides the basis for comparing the consequences of project-scale design and operation under modes of volumetric equity and iso-efficiency. A methodology to subdivide the project area into distinct portions is developed. A sample application indicates that there could be a wide variation in flow requirements in the three modes. Variations in net on-farm benefits under modes of project-scale optimality and volumetric equity are also large. The sample study indicates that the iso-efficiency design results in near-optimal project-scale returns with uniform unit benefits in the different areas. (Author's abstract)
W89-05960

ALLOCATION OF INCREMENTAL IRRIGATION BENEFITS,
Water Conservancy Hydroelectric Power Scientific Research Inst., Beijing (China).
W. Hengan, and X. Yonjiu.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 664-673, November 1988. 5 fig, 1 tab, 8 ref.

Descriptors: *Irrigation programs, *Estimated benefits, *Project planning, Available water, Water supply, Agriculture, Statistical analysis, Operating costs, Crop production, Humid areas.

Methods of calculating irrigation project profits are described systematically. Generally speaking, there are two kinds of allocation methods: (1) allocate gross incremental products of agriculture (calculate the incremental products allocated to irrigation), or (2) determine the net income of incremental agricultural production as the irrigation allocation benefit deducted from the cost of agricultural production. With regard to the first method, the following allocation methods are given: (1) analysis of historical and statistical data, (2) analysis of incremental agricultural benefit and experimental data, and (3) analysis based on crop guaranteed rate curves. Where there is a complete set of data on historical investigations and statistical materials, the first category of the first allocation method may be used. Where there are some experienced materials of incremental irrigation benefit or a nearby region has the same basic natural geographical conditions with experimental material of incremental irrigation benefit, the second category of the first allocation method is suitable. In the humid and wet regions of southern China, the third category of the first allocation method should be considered for use. Where no conditions are suitable for the first allocation method, the second allocation method may be considered as desirable. (Miller-PTT)
W89-05962

WELFARE IMPLICATIONS OF TUBEWELL IRRIGATION IN BANGLADESH,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Natural Resource Economics.
For primary bibliographic entry see Field 6C.
W89-06062

VERTICAL DISTRIBUTION IN SOIL OF UNINCORPORATED SURFACE-APPLIED PHOSPHORUS UNDER SPRINKLER IRRIGATION,
Agricultural Research Service, Prosser, WA.
D. A. Lauer.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1685-1692, November-December 1988. 4 fig, 3 tab, 20 ref.

Descriptors: *Fertilizers, *Agricultural chemicals, *Soil types, *Phosphorus, *Irrigation, *Conservation cropping, Tilling, Monoammonium phosphate, Superphosphate, Ammonium polyphosphate, Vertical distribution, Quincy sand, Warden silt loam.

Determining vertical distribution of P is important in irrigated conservation cropping systems for evaluation of P fertilization because soil immobile phosphorus accumulates near the soil surface where limited tillage reduces soil mixing. The vertical distribution of P was determined in field and laboratory experiments, from surface applied monoammonium phosphate, triple superphosphate, and ammonium polyphosphate. Following P application, vertical distribution was determined from 2 cm depth increment samples in a Quincy sand, a Warden silt loam, and a calcareous subsoil of the Warden. There was little effect on P distribution from antecedent moisture; fertilizer rates at 30, 60, 120, or 240 kg P/ha; or from preirrigation reaction times of 1, 4, or 16 d. Continuous postapplication irrigation totals of 40 or 160 mm at 10 mm/d moved P somewhat deeper into the soil, principally at 160 mm on the Quincy sand. Overall mean penetration depths of P were as follows: ammonium polyphosphate moved the farthest in the Quincy sand; penetrations were practically the same for monoammonium phosphate or triple superphosphate on the Quincy sand and on the noncalcareous Warden silt loam; depth of penetration was intermediate for ammonium polyphosphate on the noncalcareous Warden; and downward movement in the calcareous Warden of P from all fertilizer P materials was much more restricted than on the two noncalcareous soils. The most apparent conclusion from this study is that the reactivity of P fertilizer material with the soil is the dominant and overriding determinant of the vertical distribution of surface applied P. (Author's abstract)
W89-06084

LEAF WATER POTENTIAL AND LEAF CONDUCTANCE DURING THE GROWING SEASON IN ALMOND TREES UNDER DIFFERENT IRRIGATION REGIMES,
Centro de Edafologia y Biologia Aplicada del Segura, Murcia (Spain).
M. C. Ruiz-Sanchez, A. Torrecillas, F. del Amor, A. Leon, and J. M. Abrisqueta.
Biologica Plantarum (Praha) BPABAJ, Vol. 30, No. 5, p 327-332, 1988. 3 fig, 2 tab, 12 ref.

Descriptors: *Trees, *Leaves, *Water potentials, *Conductance, *Drop irrigation, *Agriculture, *Fruit crops, Almond trees, Seasonal variation.

Seasonal changes in leaf water potential (psi) and leaf conductance (gl) were determined in almond trees under four different drip irrigation regimes. The almond trees were grown since the planting under daily drip irrigation or non irrigation receiving rainfall only. Rainfall for 1985 was 209 mm, of which 156.4 occurred during the experimental period. Annual evaporation by a class A pan on bare soil was 1803 mm, of which 1488 mm occurred between April and November. The drip irrigated trees were submitted from March 1983 to four different irrigation volumes calculated according to four pan evaporation coefficients (0.11, 0.16, 0.22, 0.27), which were increased each year in accordance with the rate of the vegetative growth (trunk circumference). In this sense the amount of water applied during 1985 for each treatment was: 2071, 3107, 4139, 5175 cu m/ha. The development of water stress in the rain-fed treatment induced specific seasonal dynamics of psi values and an important reduction in gl values. A decrease in gl values occurred independently of the irrigation treatment through the growing season. No statistically significant differences were obtained in gl values within the drip-irrigated treatments. (Brock-PTT)
W89-06385

POROUS PIPE RETURNS AS MUNICIPAL WATERING ALTERNATIVE,
Dallas Dept. of Public Works, TX.
R. Underwood.
Public Works PUWOAH, Vol. 119, No. 13, p 31-32, December 1988.

Descriptors: *Parks, *Irrigation, *Subsurface irrigation, *Pipes, *Water conservation, Technology, Texas, Rubber, Root zone, Growth, Turf grasses, Porous media, Valves.

Advantages in technology and quality control have improved the performance of porous pipe in irrigation. Made of commercial grade rubber tubing, the pipe is installed underground, where it uniformly dispenses water to the root zone, promoting deep root growth, eliminating wet/dry cycles, and producing dramatic water savings. Its flexibility makes it well suited to diverse outdoor plantings and specialty turf areas. It also creates no runoff, while helping to conserve water. Manufacturers now offer flush lines and ports to keep the system clog-free, as well as a pressure-compensating flow-regulating valve which, coupled with a pressure gauge, signals when a system needs flushing or repair. Porous pipe has been used for two median strip projects at a public park and the entrance to a large city neighborhood in the Oak Cliff section of Dallas, TX. The system is fulfilling the irrigation needs it was designed for, and has eliminated evaporation problems. (Doria-PTT)
W89-06551

CROP FACTORS IN RELATION TO MAKKINK REFERENCE: CROP EVAPOTRANSPIRATION,
Institute for Land and Water Management Research, Wageningen (Netherlands).
For primary bibliographic entry see Field 2D.
W89-06701

EVALUATION OF SUBSURFACE AND OUTFLOW WATER QUALITY FROM A DRAINAGE-SUBIRRIGATION SYSTEM IN THE GEORGIA FLATWOODS,
Georgia Coastal Plain Experiment Station, Tifton. Dept. of Agricultural Engineering.
D. L. Thomas, A. Shirmohammadi, and R. Lowrance.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 208848/AS, price codes: A03 in paper copy, A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 04-87, March 1987. 41p, 12 fig, 3 tab, 23 ref, 2 append. USGS contract 14-08-301-G1219. USGS project G1219-076.

Descriptors: *Subsurface irrigation, *Subsurface drainage, *Water quality, *Chemical analysis, Nitrates, Ammonium, Phosphates, Hydrogen ion concentration, Chlorides, Electrical conductivity, Georgia, Flatwoods, Simulation analysis.

Nitrate-N, ammonium-N, pPhosphate-P, pH, electrical conductivity, and chloride concentrations were measured from shallow subsurface wells and outlets of a drainage-subirrigation system in the Georgia flatwoods. These data were compared to shallow subsurface water quality from adjacent forested and cleared areas. Nitrate-N concentrations were significantly higher in the drained-subirrigated area than in the forested and cleared areas. Nitrate-N concentrations did not exceed 10 mg/L from any of the outflow samples even though several infield samples did exceed this limit. Ammonium-N concentrations were not high and do not appear to be a problem in this drainage-subirrigation system based on the limited data available. The low phosphate-P concentrations of the outflow samples (less than 0.05 mg/L) indicates that the low clay content, sandy soils of this area have considerable ability for phosphate-P fixation and may not promote excessive leaching of phosphate. The pH of all the shallow well sites were significantly lower than the inflow, outflow and surface water samples. The effect of the water supply on the outflow samples during the irrigation phase was evident in the pH results. The electrical conductivity and chloride concentrations were significantly higher in the drained-subirrigated field than in the cleared and forested areas. The drought period in 1986 showed a marked increase in chloride concentration under the drainage-subirrigation field, but the levels decreased after sufficient rainfall leached the salts from the soil. Preliminary simulations using CREAMS-WT (a derivative of the CREAMS model) on a field with similar characteristics to the drainage-subirrigation site, indicate that the potential nutrient losses in surface runoff were not severe. Additional simulations will provide a better evaluation of the models applicability to the Georgia flatwoods. (Thomas-GA U)
W89-06913

ECONOMIC ASPECTS OF WESTERN SURFACE WATER ALLOCATION,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6D.
W89-06919

ALLOCATION OF GROUNDWATER RIGHTS ON THE BASIS OF FARMERS' CONSUMPTIVE WATER NEEDS,
Oklahoma Univ., Norman. Dept. of Geography.
For primary bibliographic entry see Field 6D.
W89-06922

CASE STUDY OF IRRIGATION WATER MANAGEMENT AT KAUDULLA IRRIGATION SCHEME AND DEVELOPMENT OF WATER MANAGEMENT ALTERNATIVES FOR THE DRY ZONE OF SRI LANKA,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Graduate School in Environmental Sciences and Engineering.
K. G. A. Goonasekere.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8605441. Ph.D. Dissertation, 1985. 385p, 31 fig, 21 tab, 76 ref, 2 append.

Descriptors: *Developing countries, *Irrigation programs, *Water resources development, *Irrigation practices, *Management planning, Irrigation efficiency, Surface irrigation, Irrigation design, Social aspects, Economic factors, Farming, Sri Lanka.

System and farm level irrigation management in the dry zone of Sri Lanka were studied to identify constraints on effective management, distribution, and productivity of irrigation water. Field observations and monitoring of irrigation flow showed that irrigation management in the Kaudulla Stage I irrigation system was inefficient. Inadequate control facilities and neglected maintenance of the channel system were the primary reasons for ineffective water distribution. Lack of motivation among system management personnel also contributed to inefficient management. The extremely long distributory and field channel layout and design of drop structures represented poor engineering design for the field conditions at the Kaudulla facility. Although the engineering system and other physical facilities are location specific, similar findings in relatively new irrigation systems indicate that the socioeconomic constraints to effective irrigation management are common within almost all of the irrigation systems in the dry zone. The inferior economic status of individual farmers affected productivity at the farm level. (Cremmins-AEPCO)
W89-06932

WASTEWATER APPLICATION TO SOILS: HYDRAULIC AND NITROGEN CONSIDERATIONS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agronomy.
For primary bibliographic entry see Field 5E.
W89-06933

OPTIMIZATION AND SIMULATION METHODOLOGY FOR IRRIGATION PLANNING,
California Univ., Davis.
J. Chaves-Morales.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8607573. Ph.D. Dissertation, 1985. 234p, 14 fig, 54 tab, 59 ref, 3 append.

Descriptors: *Model studies, *Optimization, *Management planning, *Irrigation districts, Simulation analysis, Surface irrigation, Computer models, Linear programming.

An optimization and simulation planning methodology was developed for the management of an operating irrigation district. The district is located in an arid environment, with an already built reservoir of known capacity, an aquifer with an estimated firm yield, and a canal network to transport waters to farms within the district. The methodology is based on: (1) an optimization model that defines the optimal cropping pattern that would produce the optimal profit for farmers and a schedule of the seasonal reservoir and aquifer operating policies; and (2) a simulation model that reproduces the irrigation system performance under the management policies defined by the optimization model of those specified by the planners. The simulation model also supports the evaluation or benefits accrued from hydropower generated by reservoir releases for agriculture. The optimization model is formulated using linear programming and solved in a mainframe computer; the simulation model is programmed to be run on a microcomputer. The models were applied to the management planning for an irrigation district in northern Mexico. (Cremmins-AEPCO)
W89-06945

WATER USE AND IRRIGATION RESPONSE TO DEFOLIATED CORN WITH VARIOUS POPULATIONS,
Nebraska Univ.-Lincoln.
K. G. Rao.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8706243. Ph.D. Dissertation, 1986. 142p, 36 fig, 43 tab, 73 ref, append.

Descriptors: *Water use, *Irrigation water, *Corn, *Plant growth, *Crop production, Defoliants, Evapotranspiration, Sprinkler irrigation, Hydrologic budget.

The effect of defoliation on water use by corn was studied at several populations by using water gradient levels, and the growth and yield response of defoliated corn to the application of irrigation water was measured. Between 1981 through 1983, six main plots were laid out as non-randomized water gradients, four subplots as 25,000-70,000 plants/hectare, and two sub-subplots as two defoliation treatments by using line source sprinkler irrigation. Yield increased linearly as the water gradient increased from 20 to 80%. There were no major gradient differences in 1981 or 1982. But a clear differentiation among water gradients was observed in 1983, when unusual dry and hot conditions prevailed during the reproductive growth stages. A linear increase in dry matter was observed with the increase in time. The effect of water gradient was readily apparent from pollination onwards; however, the magnitude of difference of dry matter at the 0% level was less at different stages. Statistical analysis for dry matter production/plant indicates a significant linear response among plant populations. A linear relationship was found between evapotranspiration and yield. The smallest slopes were obtained in 1981 and 1982; the greatest differences between water gradients occurred in 1983, a stressful season. (Cremmins-AEPCO)
W89-06952

ALFALFA WATER-PRODUCTION FUNCTIONS UNDER CONDITIONS OF DEFICIT IRRIGATION WITH SALINE WATER,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
For primary bibliographic entry see Field 3C.
W89-06959

WATER MANAGEMENT FOR LOWLAND RICE IRRIGATION,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
F. Z. Siddeek.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704699. Ph.D. Dissertation, 1086. 210p, 33 fig, 10 tab, 60 ref, 4 append.

Descriptors: *Water use, *Hydrologic budget, *Rice, *Irrigation requirements, *Surface irrigation, *Irrigation canals, *Model studies, Simulation analysis, Water conveyance, Management planning, Southeast Asia.

A management system was developed to improve water use in irrigated paddies in Southeast Asia. Rainfall and evaporation data were obtained to determine irrigation requirements. Different transformations were applied to normalize the data on rainfall and evaporation. Irrigation water requirements that were estimated using a model showed significant water savings. To manage the irrigation system to reflect the changing demands in the fields it is necessary to measure the initial water level in the fields at the beginning of each day. An EXTRAN hydraulic flow routing model was shown to be a valuable tool for determining required gate settings at turnouts so that water could be distributed to channels to meet demands. Flow simulation indicated that appreciable time elapsed after changes in the discharge from the reservoir before responses were observed at turnouts, owing to the large distances between the reservoir and the turnouts. (Cremmins-AEPCO)
W89-06962

MANAGING SALINE WASTE WATER FOR CROP PRODUCTION AND MINIMUM LEACHING,
California Univ., Riverside. Graduate Program in Soil Science.
For primary bibliographic entry see Field 3C.
W89-06963

COMPUTER DECISION SUPPORT FOR WATER SUPPLY DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
H. R. Horsey.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8618181. Ph.D. Dissertation, 1986. 325p, 35 fig, 10 tab, 31 ref, 6 append.

Descriptors: *Water distribution, *Water conveyance, *Water supply, *Computer programs, *Rural areas, *Decision making, Agricultural hydrology, Simulation analysis, Data collections, Management planning.

A computer-assisted, rural agricultural water distribution system DSS (RAWDSS) was developed. The system consists of simulation, database, and dialogue management subsystems. The simulation subsystem allows the simulation of any open-channel water supply system and the rapid introduction of alternative system configurations. Within the system, canal locations, sizes, geometry, lengths, and reservoir locations and sizes are easily adjustable. The simulation time step and the length of the simulation period are also adjustable. The database subsystem provides a rudimentary relational database with search, sort, and extract capabilities, as well as standard statistical functions. The dialogue management subsystem provides both graphical and textual report generation, an interactive menu based user interface, and built-in command procedures for automating many of the simulation and database subsystem operations. The system was developed specifically for the iterative, multiobjective unstructured decision process common to water resource development. (Cremmins-AEPCO)
W89-06968

4. WATER QUANTITY MANAGEMENT AND CONTROL

4A. Control Of Water On The Surface

OPERATIONAL GUIDANCE DURING DROUGHTS: EXPERT SYSTEM APPROACH,
Washington Univ., Seattle. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W89-05819

INFLUENCE OF DIFFERENT DOWNSTREAM USERS ON SINGLE MULTIPURPOSE RESERVOIR OPERATION BY CHANCE CONSTRAINTS,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
S. Simonovic.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 596-600, August 1988. 4 fig, 3 tab, 5 ref.

Descriptors: *Model studies, *Reservoir operation, *Multipurpose reservoirs, *Water use, Mathematical models, Algorithms, Yugoslavia, Management planning, Decision making, Long-term planning, Reservoir releases, Minimum flow, Computer programs.

A chance-constrained model is applied to solve the problem of long-term planning of the operation of a single multipurpose reservoir. Apart from the direct multipurpose use of water from the reservoir downstream, releases are available for use. The influence of downstream users is taken into account by a special form of objective function. Releases are bounded by the capacity of the outlet works above and by the guaranteed minimum flow from below. These two bounds are constraints on the control space. The model uses a chance-constrained programming algorithm to yield the control trajectory (releases) closest to the optimum. The properties of the chance-constrained program reveal a strong influence of changes of the control space on releases. This enables a release strategy to be derived which will increase the utilization of water from the reservoir. The model is applied to the Prohor Reservoir on the Pcinja River in the Vardar River basin, Yugoslavia. (Author's abstract)
W89-05826

SOME ALTERNATIVE APPROACHES TO MATHEMATICAL MODELLING OF RESERVOIR SYSTEMS,
Durban-Westville Univ. (South Africa).
A. J. Tollow.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 5, p 565-572, November-December 1988. 2 fig, 25 ref.

Descriptors: *Reservoir operation, *Programming methods, *Management planning, *Mathematical models, Simulation, Control bands, Cost analysis, Drought, Optimization.

Four basic methods of devising an operating policy for reservoirs exist, namely dynamic programming, linear programming, non-linear programming, and simulation. Simulation is the most popular; however, it does not in itself yield an optimal solution. In practice this may not be a disadvantage, especially when simulation is used to create 'control bands.' All the methods at one stage or another permit cost functions to be incorporated. The ability of simulation to include water quality constraints, as well as costs, will be of increasing benefit as the quality of available water resources deteriorates. The use of control bands and the relative simplicity of the basic simulation program permit the day-to-day operation to be delegated. The ease with which the segment containing costs can be changed is a major benefit. Control bands can be derived from median and low flows. However, during drought additional monitoring likely will be needed if control bands derived from hindsight are used for forecasting. A single reservoir may be operated in conjunction with several others, each of which has its own individual operating band, but conforming to group policy. To the extent that optimization methods other than simulation are more incomprehensible to the user, they tend to be less used. (Rochester-PTT)
W89-05836

BENEFITS AND COSTS OF ALLOCATING SPACE IN AN EXISTING RESERVOIR TO RIVER REGULATION,
Ok Tedi Mining Ltd., Port Moresby (Papua New Guinea).
R. J. Higgins.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 5, p 573-581, November-December 1988. 5 fig, 2 tab, 5 ref.

Descriptors: *Storage reservoirs, *Water demand, *Economic aspects, *Cost analysis, *Flood protection, Optimization, Wyangala Dam, New South Wales, Australia, Lachlan Valley, Airspace allocation, Design criteria.

Subsequent to the selection of design capacity and the construction of a storage reservoir, water demands, valley land use, and economic constraints may change and reallocation of storage space in an existing reservoir may become desirable. The benefits of reallocating space to flood mitigation are the equivalent annual flood damages averted, whereas the costs arise from water shortages that would not have occurred if space had not been reallocated. These benefits and costs can be quantified for a particular region and the optimal airspace provision calculated. In a case study area (Wyangala Dam, Lachlan Valley of central New South Wales, Australia), reallocation of part of the storage volume was justified, whereas excessive reallocation would result in significant net costs to the region. The optimum airspace allocation was not sensitive to the value assigned to water. The procedure used here could be applied to other river valleys, where the solution would depend on the intensity of land use, which influences both potential flood damages and the costs of water shortages. (Author's abstract)
W89-05837

INFLUENCE OF REGULATION ON ENVIRONMENTAL CONDITIONS AND THE MACROINVERTEBRATE COMMUNITY IN THE UPPER COLORADO RIVER,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
For primary bibliographic entry see Field 6G.
W89-05839

SHORT-TERM FORECASTING OF SNOWMELT RUNOFF USING ARMAX MODELS,
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 2E.
W89-06065

EFFECTS OF SALINITY AND WATERLOGGING ON THE VEGETATION OF LAKE TOOLIBIN, WESTERN AUSTRALIA,
Western Australia Univ., Nedlands. Dept. of Botany.
For primary bibliographic entry see Field 4C.
W89-06373

EFFECT OF SELECTED DYES ON THE GROWTH OF DUCKWEED,
University of South Florida, Tampa. Dept. of Chemistry.
D. F. Martin, and C. D. Norris.
Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 765-771, 1988. 1 tab, 13 ref.

Descriptors: *Duckweed control, *Aquatic plants, *Dyes, *Nuisance plants, *Aquatic weed, control, Plant growth, Singlet oxygen, Oxygen.

Lemna obscura (Austin) Daubs (duckweed) was used as a bioassay organism to test the effect of methylene blue and four fluorescein-derivatives (substituted xanthenyl benzoates: rose bengal, eosin Y, erythrosin, and fluorescein) for their effect as sensitizers in the production of singlet oxygen. Growth was measured as the area of mono-layer plant growth, which had been related to the plant fresh weight. The effect of the dye was evaluated under low light levels in the laboratory as differences in the change in mono-layer area for test in comparison with untreated plants. The relative growth fraction (fraction of area covered after one week divided by the fraction of area covered initially) was a linear function of the known quantum yield for dye-sensitized singlet oxygen production for three fluorescein dyes and methylene blue ($r = 0.97$; $P = 0.001$). Erythrosin was less effective than expected and did not conform to the correlation. (Author's abstract)
W89-06410

BIG RESERVOIRS LINED IN DAYS,
Rainbow Municipal Water District, Fallbrook, CA.
For primary bibliographic entry see Field 8A.
W89-06549

FLOODING IN THE DESERT: TAKING CONTROL,
Black and Veatch, Las Vegas, NV.
D. V. Reel, and L. S. Bond.
Public Works PUWOAH, Vol. 119, No. 13, p 29-30, 79, December 1988.

Descriptors: *Flood control, *Detention reservoirs, *Embankments, *Deserts, Nevada, Earthworks, Storm runoff, Detention dams, Taxes, Costs, Public participation, Planning, Spillways, Construction materials.

A history of chronic flooding in Las Vegas and other parts of Clark County, NV has prompted the development of a multimillion-dollar county-wide flood control plan and construction of three detention basins. The Red Rock Wash Stormwater Detention Basin, completed in April 1987, is the most recent of these and the first of two being built to limit peak stormwater discharges in the Flamingo Wash Watershed. The facility was designed and

built in 16 months. The detention basin consists of an earthen embankment and impoundment area and a reinforced concrete emergency spillway and outlet works. It has a capacity of 1,860 acre-ft and occupies more than 80 acres. The detention basin embankment was constructed of coarse-grained alluvial sands and gravels, designed as a pervious embankment on a pervious foundation. The basin provides flood protection by detaining stormwater and gradually releasing it over a 24-hour period. The Flamingo Wash Detention Basin and outlet channel are currently being designed. The Flood Control District's 10-year plan will cost an estimated $179 million, and is financed by a sales tax approved by Clark County voters. The District's flood control measures are supported and promoted by an active citizen's advisory committee. (Doria-PTT)
W89-06550

IMPROVED METHODOLOGY FOR SHORT-TERM OPERATION OF A SINGLE MULTI-PURPOSE RESERVOIR,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
S. P. Simonovic, and D. H. Burn.
Water Resources Research WRERAO, Vol. 25, No. 1, p 1-8, January 1989. 6 fig, 4 tab, 19 ref. University of Manitoba Research grants 431-2720-21 and 431-2720-22.

Descriptors: *Reservoir operation, *Multipurpose reservoirs, *Streamflow forecasting, *Mathematical models, Optimization, Forecasting, Kentucky.

The existence of several problems associated with the short-term operation of multipurpose reservoirs has been demonstrated in the past. A principal difficulty arises from uncertainties inherent in the prediction of future stream flows which are required to effect the requisite reservoir operation. It has been shown that the performance of the reservoir operation, as determined by an optimization model, is a function of the operating horizon. This results from the existence of a relationship between the operating horizon and both the reliability of the inflow forecasts and the reservoir operation. With an increase in the length of the operating horizon, the reliability of the forecasts will necessarily decrease. However, the reservoir operation model yields an improved operation on the assumption that the forecasts are accurate. An improved methodology is presented which considers the operating horizon as a decision variable which can change in real time. The optimal value of the operating horizon is selected based on the trade-off between more reliable inflow forecast for shorter horizons and better reservoir operation associated with the use of longer operating horizons. The benefits of the new methodology are illustrated through an application of the technique in simulating the operation of Green Reservoir in Kentucky. (Author's abstract)
W89-06574

GUIDELINES FOR DETERMINING FLOOD FLOW FREQUENCY.
Geological Survey, Washington, DC. Office of Water Data Coordination.
For primary bibliographic entry see Field 7C.
W89-06662

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES FROM URBAN BASINS IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06831

ANALYSIS OF WATER-SURFACE PROFILES IN LEON COUNTY AND THE CITY OF TALLAHASSEE, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06833

MAGNITUDE AND FREQUENCY OF FLOODS IN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06835

VERIFICATION OF REGRESSION EQUATIONS FOR ESTIMATING FLOOD MAGNITUDES FOR SELECTED FREQUENCIES ON SMALL NATURAL STREAMS IN GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06837

STATISTICAL SUMMARIES OF STREAMFLOW RECORDS IN OKLAHOMA AND PARTS OF ARKANSAS, KANSAS, MISSOURI, AND TEXAS THROUGH 1984,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06885

4B. Groundwater Management

ARTIFICIAL RECHARGE IN LAS VEGAS VALLEY, CLARK COUNTY, NEVADA,
Las Vegas Valley Water District, NV.
T. Katzer, and K. Brothers.
Ground Water GRWAAR, Vol. 27, No. 1, p 50-56, January-February 1989. 3 fig, 5 tab, 9 ref.

Descriptors: *Artificial recharge, *Groundwater recharge, *Las Vegas Valley, *Nevada, Colorado River, Water quality, Surface-groundwater relations, Calcite, Precipitation, Feasibility studies.

The existing water supply system for Las Vegas Valley is limited since peak water used demand periods in 10-20 yr or less will require the construction of additional facilities. To prepare for these short-term (and longer) demands, the Las Vegas Valley Water District, in cooperation with the U.S. Bureau of Reclamation, conducted a limited groundwater recharge demonstration project using treated Colorado River water. A major concern of water managers regarding artificial recharge is the resulting water chemistry when treated (potable) Colorado River water is injected into the groundwater system. Both waters are high in calcium, creating a potential for calcite precipitation which, in addition to clogging the perforations in the water well casing, could potentially reduce aquifer permeabilities by clogging the pore space of the flow media. Approximately 525,000 gallons of potable water were injected into a semiconfined groundwater aquifer over a three-day period interspersed with two pumping periods. Water chemistry samples taken throughout the injection project showed no imbalance with regard to calcium or any other chemical constituent. Therefore, artificial recharge is feasible and is one water resource technique available to meet an increasing water demand based on the existing water quality of the Colorado River and the quality of the groundwater in the area of injection. (Author's abstract)
W89-06204

CREATION OF AN ARTIFICIALLY PRODUCED FRACTURE ZONE TO PREVENT CONTAMINATED GROUND-WATER MIGRATION,
Dunn Geoscience Corp., Albany, NY.
For primary bibliographic entry see Field 5G.
W89-06205

COMMON PROPERTY AQUIFER AS A DIFFERENTIAL GAME,
Economic Research Service, Washington, DC. Resources and Technology Div.
D. H. Negri.
Water Resources Research WRERAO, Vol. 25, No. 1, p 9-15, January 1989. 2 fig, 24 ref.

Descriptors: *Water use, *Water allocation, *Aquifer management, *Competing use, *Groundwater depletion, *Mathematical models, *Pumping, Farms, Groundwater management, Hydrologic models.

Open-loop and feedback equilibria were compared using a common property aquifer model. Open-loop solutions correspond to assuming that participants commit themselves in the initial period to pumping rates in all future periods. Feedback solutions represent a more realistic assumption as farm operators adopt pumping strategies that depend on the reserve stock of water. Comparing the two equilibrium concepts revealed two sources of dynamic inefficiency in the common property aquifer: a pumping cost externality and a 'strategic externality' that arises from the competition among users to capture the groundwater reserves. The qualitative results show that the open-loop solution captures only the pumping cost externality. The feedback solution captures both externalities and exacerbates the overexploitation of the commons compared to the open-loop solution. Moreover, the dynamic inefficiency resulting from both externalities increases in the number of independent landowners with access to the aquifer. (Author's abstract)
W89-06575

WORKSHOP DESIGN FOR SPRING CAPPING: A TRAINING GUIDE,
Water and Sanitation for Health Project, Arlington, VA.
W. Gormley, D. Goff, and C. Johnson.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 28, September 1984. 527p. WASH Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Handbooks, *Spring capping, *Retaining, *Water supply development, *Water management, *Training, Rural areas, Springs, Education, Groundwater, Project planning, Public participation, Community development.

The purpose of this training guide is to provide participants with the needed skills and knowledge for assisting rural communities to organize, implement, and maintain spring capping projects. Therefore, planning, constructing, and maintaining retaining walls for springs is the central theme of this training. This training guide is for trainers who will conduct the workshop. It is not for participants although it contains materials which will be handed out to them. The workshop is for participants who work in rural settings with local communities which want to improve their spring water supply, and as such it is designed for individuals without prior technical skills or knowledge needed to plan and construct spring capping improvements. At the end of this workshop, trainees will be able to: identify resources necessary to complete a village spring capping project; communicate with village leaders and promote activities needed for project implementation; identify and apply strategies for involving the community in spring capping activities; survey and evaluate sites for potential spring capping; communicate and apply relevant theories about water and its relationship to environment and health; develop and implement work plans and logistics necessary for project start-up; coordinate and supervise work force and delivery of materials; design and build a retaining wall for capping springs; describe three alternative spring capping systems: the spring box, seepage collection, and storage tank systems; use, maintain, troubleshoot, and repair retaining wall spring capping systems; identify strategies for solving the most common problems which develop while building spring capping retaining walls; evaluate a spring capping project and document and record information gathered for future use; and develop action plans for implementing spring capping projects in their regular work environments. (Lantz-PTT)
W89-06603

WORKSHOP DESIGN FOR WELL IMPROVEMENT: PROTECTING OPEN WELLS,
Water and Sanitation for Health Project, Arlington, VA.

M. Nagorski, and C. Pineo.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 34, May 1988. 345p. WASH Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water pollution prevention, *Wells, *Open wells, *Well construction, *Water resources management, Rural areas, Sanitation, Water supply development, Training, Handbooks, Community development, Shallow wells, Drainage, Construction, Maintenance.

The training workshop outlined in this guide is to provide participants with the skills and knowledge needed for assisting rural communities to organize and implement well improvement projects. The overall focus is on making shallow open wells more sanitary by making above ground improvements through constructing a headwall and an apron. The workshop does not deal with increasing the yield of the well or with installing a handpump. This guide is intended to be used by the trainer(s) who will conduct the workshop. It is not a guide for the participants, although it contains materials which will be handed out to them. The workshop is intended for participants who work in rural areas with local communities who want to improve the sanitary conditions of their water supply. It is designed for individuals lacking the technical skills or knowledge needed to plan and construct well improvement projects, or for those who desire to practice, review, and refine their present level of knowledge and skill. At the end of the workshop, participants will be able to: explain the benefits of improving wells; work with village leaders and groups to initiate, implement, and follow through with a sanitary improvement project for dug wells; assist villages to assess the need for improving well conditions and identify the major categories of improvements; fabricate and make use of concrete blocks; mix and pour concrete with appropriate reinforcement; design and construct a headwall; design and construct a sloped apron with adequate backfill and an appropriate structure for draining water; develop user education strategies demonstrating clean water storage and handling techniques and well maintenance and usage; estimate and plan the type, quantity, and basic costs of material and labor needed for a proposed project; describe the importance of a continuing well maintenance program; and recognize construction problems in existing wells and determine if a structure should be repaired or replaced. (Lantz-PTT)
W89-06604

DEVELOPMENT OF A COMBINED QUANTITY AND QUALITY MODEL FOR OPTIMAL GROUNDWATER MANAGEMENT,
Arkansas Water Resources Research Center, Fayetteville.
R. C. Peralta, J. Solaimanian, S. A. Prathapar, and C. L. Griffis.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-133772. Price codes: A03 in paper copy, A01 in microfiche. Publication No. 127, June 1987. 20p, 10 fig, 12 ref. Research Project G-1212-04.

Descriptors: *Water supply, *Water quality, *Groundwater management, *Model studies, Quantitative analysis, Path of pollutants, Computer models, Groundwater quality, Solute transport.

A procedure for incorporating solute transport as linear constraints within computer models for optimizing regional groundwater extraction strategies, is presented. The MODCON modelling procedure uses linear goal programming, embedded linearized equations for the flow and solute transport and a methods of characterization (MOC) simulation model. Assumed is 2D flow and solute transport and a dispersed conservative contaminant. The MODCON procedure develops steady groundwater extraction strategies that will satisfy future groundwater quality constraints while simultaneously causing future piezometric heads to be as close to current heads as possible. The procedure is applied to a 160 sq mi area in southeastern Arkansas. (Author's abstract)
W89-06655

GROUNDWATER RECHARGE AS A TREATMENT OF SEWAGE EFFLUENT FOR UNRESTRICTED IRRIGATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 5D.
W89-06809

UK EXPERIENCE IN THE GROUNDWATER RECHARGE OF PARTIALLY TREATED SEWAGE: POTENTIAL FOR IRRIGATION PURPOSES,
For primary bibliographic entry see Field 5D.
W89-06810

PLANNING REPORT FOR THE EDWARDS-TRINITY REGIONAL AQUIFER-SYSTEM ANALYSIS IN CENTRAL TEXAS, SOUTHEAST OKLAHOMA, AND SOUTHWEST ARKANSAS,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06840

OVERVIEW OF WATER RESOURCES IN OWENS VALLEY, CALIFORNIA,
Geological Survey, Sacramento, CA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06844

PROJECTED WATER-LEVEL DECLINES IN THE OGALLALA AQUIFER IN LEA COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06856

GEOHYDROLOGY OF THE DELAWARE BASIN AND VICINITY, TEXAS AND NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06857

PROJECTED EFFECTS OF GROUND-WATER WITHDRAWALS IN THE ARKANSAS RIVER VALLEY, 1980-99, HAMILTON AND KEARNY COUNTIES, SOUTHWESTERN KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
L. E. Dunlap, R. J. Lindgren, and J. E. Carr.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4082, 1984. 168p, 28 fig, 2 tab, 7 ref.

Descriptors: *Kansas, *Surface-groundwater relations, *Groundwater irrigation, *Water resources development, *Groundwater budget, *Arkansas River, Wells, Streamflow, Groundwater recharge, Irrigation, Projections.

A study was made to determine the effects that additional groundwater development would have on streamflow and water levels. A computer model was used to simulate the changes in streamflow and water levels from 1980 through 1999. Six pumpage options were tested using variations in pumpage rate and number of wells pumping in the model area. The projected effects of groundwater withdrawals from 1980-99 indicate that net annual streamflow losses would be reduced only 1% if annual withdrawals were reduced by 24% from the continued 1979 pumpage rate of wells with water rights, as computed using energy consumption techniques, to the amount appropriate by water rights for these wells. The higher pumpage rate results in very little change in stored groundwater and net streamflow losses because, after satisfying initial soil moisture requirements, a greater percentage of the additional applied water percolates back to the aquifer. If pumpage were increased along with an increase in the number of irrigated acres over the 1979 rate, additional water would be removed from storage, and net annual streamflow losses would increase. A 19% increase in pumpage over the 1979 rate, with the additional acres irrigated, would cause the net annual streamflow loss to increase from 5% to 9%. (Author's abstract)
W89-06858

GROUND-WATER RESOURCES IN THE ROSS BARNETT RESERVOIR AREA, MISSISSIPPI,
Geological Survey, Jackson, MS. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06862

GROUND-WATER RESOURCE ASSESSMENT OF THE MONTAUK AREA, LONG ISLAND, NEW YORK,
Geological Survey, Syosset, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06870

GROUND-WATER SYSTEM AND SIMULATED EFFECTS OF GROUND-WATER WITHDRAWALS IN NORTHERN UTAH VALLEY, UTAH,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06871

SIMULATED WATER LEVEL DECLINES CAUSED BY GROUNDWATER WITHDRAWALS NEAR HOLLOMAN AIR FORCE BASE, OTERO COUNTY, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
A. W. Burns, and D. L. Hart.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4324, 1988. 44p, 16 fig, 3 tab, 17 ref.

Descriptors: *Groundwater withdrawals, *Water levels, *New Mexico, Aquifer systems, Pumpage.

The U.S. Geological Survey, in cooperation with the U.S. Air Force, Holloman Air Force Base, studied the potential change in water levels that could occur as a result of increased groundwater withdrawals from the middle-Tertiary to Holocene age basin-fill and alluvial deposits in the vicinity of the Air Force base in Otero County, New Mexico. Water level changes of 25 ft to as much as 60 ft below their 1982 levels are projected in the well field areas by the year 2001, based on an increased groundwater withdrawal of 10%. The 400-sq-mi area of unconsolidated material is relatively flat except for the alluvial fans adjacent to the mountain front. Perennial streams are not present in the study area. The aquifer has a saturated thickness that ranges from 0 to 3 ft. Intermittent streamflow from the nearby mountains infiltrates the alluvial fans and recharges the aquifer system. Groundwater is discharged from the area by underflow, evapotranspiration, and pumpage withdrawals from wells. (USGS)
W89-06883

GEOHYDROLOGY AND 1985 WATER WITHDRAWALS OF THE AQUIFER SYSTEMS IN SOUTHWEST FLORIDA, WITH EMPHASIS ON THE INTERMEDIATE AQUIFER SYSTEM,
Geological Survey, Tampa, FL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06887

GROUNDWATER WITHDRAWAL AND WATER LEVEL DATA USED TO SIMULATE REGIONAL FLOW IN THE MAJOR COASTAL PLAIN AQUIFERS OF NEW JERSEY,
Geological Survey, Trenton, NJ.
For primary bibliographic entry see Field 2F.
W89-06889

MICROCOMPUTER PROGRAM FOR ESTIMATING DROUGHT STREAM-FLOW REDUCTION DUE TO PUMPING FROM NEARBY WELLS,
Georgia Univ., Athens. School of Forest Resources.
For primary bibliographic entry see Field 2A.
W89-06894

GROUNDWATER HYDROLOGY OF THE JASPER (MIOCENE) AQUIFER IN THE SOUTHEAST TEXAS COASTAL PLAIN,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06915

POLITICAL ECONOMY OF INSTITUTIONAL INNOVATION: COALITIONS AND STRATEGY IN THE DEVELOPMENT OF GROUNDWATER LAW,
Wisconsin Univ.-Madison.
For primary bibliographic entry see Field 6E.
W89-06939

OPTIMAL WELL LOCATION IN A MULTI-AQUIFER GROUNDWATER SYSTEM,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-06946

SUSTAINED-YIELD GROUNDWATER BASIN MANAGEMENT: A GOAL-PROGRAMMING APPROACH,
Arkansas Univ., Fayetteville.
A. Yazdanian.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8618023. Ph.D. Dissertation, 1986. 125p, 18 fig, 7 tab, 48 ref.

Descriptors: *Sustained yield, *Safe yield, *Groundwater management, *Model studies, *Computer models, *Management planning, Groundwater basins, Linear programming, Quadratic programming, Optimization, Arkansas, Grand Prairie region.

A sustained yield strategy for groundwater basin management was calculated with the aim of maintaining a regionally optimum potentiometric surface in close approximation to a set of target levels. A goal-programming objective was used to assure that the regional sum of deviations of achieved levels from target levels was at a minimum. The goal-programming method was formulated in linear and quadratic forms in two computer models. The methodology was applied to the Grand Prairie region of Arkansas for planning sample sustained-yield pumping strategies that would approximately maintain the most recently observed groundwater elevations in that region. For sample problems consisting of up to 90 finite-difference grid points, the linear program showed significant superiority with regard to computer time efficiency, but it did not produce acceptable results when it was applied to the study area. Some of the 152 quality constraints involved were violated by the optimal solution due to numerical difficulties. Therefore, application results for the Grand Prairie were developed using the quadratic model. (Cremmins-AEPCO)
W89-06958

4C. Effects On Water Of Man's Non-Water Activities

GROUND-WATER FLOW MODEL OF DRAWDOWN AND RECOVERY NEAR AN UNDERGROUND MINE,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 2F.
W89-05876

MODELLING NITRATE REMOVAL BY RIPARIAN VEGETATION IN A SPRINGFED STREAM: THE INFLUENCE OF LAND-USE PRACTICES,
Massey Univ., Palmerston North (New Zealand). Dept. of Mathematics and Statistics.
For primary bibliographic entry see Field 2E.
W89-05882

ESTUARY REHABILITATION: THE GREEN BAY STORY,
Wisconsin Univ.-Madison. Sea Grant Inst.
P. L. Smith, R. A. Ragotzkie, A. W. Andren, and H. J. Harris.
Oceanus OCEAAK, Vol. 31, No. 3, p 12-20, Fall, 1988. 7 fig, 8 ref.

Descriptors: *Water pollution effects, *Green Bay, *Lake Michigan, *Estuarine environment, *Water quality, *Rehabilitation, *Water pollution control, Polychlorinated biphenyls, Ecosystems, Forest management, Agriculture, Pulp and paper industry, Estuarine fisheries, Wildlife habitats, Biological oxygen demand, International commissions, Domestic wastes.

Lake Michigan's Green Bay, the largest freshwater estuary in the world, has been very productive over the years. However, misuse and overexploitation of the Green Bay Estuary offers a classic example of where economic activities focused on the land and water have led not only to enormous benefits but also to large and unanticipated consequences. Starting during the industrialization of the mid-1800s, the fish, timber, land, and water of Green Bay and its watershed faced increasing pressure. Green Bay's ability to trap nutrients hastened its degradation under the increasing loads of biological oxygen-demanding wastes and suspended solids. As the forests were cleared for lumber, the clear land was converted to agriculture, and runoff from farmlands increased the nutrient load on the bay. The expanding paper industries and communities discharged increasing amounts of untreated sewage and industrial wastes into the tributaries flowing into the bay. The degradation of water quality has destabilized the aquatic ecosystem and affected the fishing industry as well as the domestic use of the bay and its tributaries, and in the early 1970s polychlorinated biphenyls (PBCs) were discovered in the water, sediments, and fish of the Fox River and Green Bay. In 1969 the University of Wisconsin Sea Grant Program initiated a comprehensive research program on Green Bay and its estuarine system. Out of this early research and along with a public recognition of the potential value of the bay, an ambitious rehabilitation program emerged, the result of which has been a dramatic decrease in waste and suspended solids, an improvement in water quality and a recovery of the fishing industry, and an increased community involvement. Under a new Great Lakes-wide program of the U.S.-Canadian International Joint Commission, lower Green Bay has been targeted as one of 42 sites for Remedial Action Plans, whose purpose is to restore the beneficial uses of degraded environments. Green Bay has also been chosen as a focal point for a Mass Balance Study of PCB contamination and its disposal. (Sand-PTT)
W89-05909

ENGINEERING AND ENVIRONMENTAL GEOLOGY OF THE INDIAN WELLS VALLEY AREA, SOUTHEASTERN CALIFORNIA,
Naval Weapons Center, China Lake, CA.
J. T. Zellmer.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 25, No 4, p 437-457, November 1988. 7 fig, 54 ref.

Descriptors: *California, *Engineering geology, *Seismology, *Groundwater availability, *Water table, *Soil profiles, Flooding, Liquefaction, Wastewater disposal, Hazardous waste disposal, Volcanoes, Indian Wells Valley, Cleanup operations.

The Indian Wells Valley area of southeastern California is affected by several geologic and geotechnical hazards and problems. These include seismic activity, a limited groundwater resource, flooding, poor soil conditions, slope instability, liquefaction susceptibility, a locally high groundwater table, sewage and hazardous waste disposal and the potential for volcanic activity. Many of the present difficulties are directly or indirectly related to the rapid wartime building of the Naval Weapons Center, China Lake, during which adequate consideration was not always given to the geologic, geotechnical and environmental factors that affect the local area and region. Now that the various problems and hazards have been recognized, efforts are underway to mitigate the deleterious effects of past actions and decisions and to prevent their recurrence. A major factor in these efforts is the increasing involvement of geologic and geotechnical data and expertise in decision making. (Author's abstract)
W89-05911

WATER RESOURCES AND ENVIRONMENTAL POLLUTION IN NIGERIA: SOME PRELIMINARY FINDINGS,
Nigerian Inst. of Social and Economic Research, Ibadan.
For primary bibliographic entry see Field 5B.
W89-06004

WATER QUALITY AFTER LOGGING SMALL WATERSHEDS WITHIN THE BULL RUN WATERSHED, OREGON,
Pacific Northwest Forest and Range Experiment Station, Corvallis, OR. Forestry Sciences Lab.
R. D. Harr, and R. L. Fredriksen.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1103-1111, October 1988. 4 fig, 6 tab, 18 ref.

Descriptors: *Oregon, *Water quality, *Forest watersheds, *Logging, *Clear-cutting, Suspended sediments, Cycling nutrients, Streams, Nitrates, Runoff, Small watersheds.

Road building, clearcutting 25% of the watershed, and slash disposal by broadcast burning or by natural decomposition caused changes in water quality of two small streams in the Bull Run Watershed in Oregon, which supplies water to the Portland, Oregon, metropolitan area. Concentrations of suspended sediment increased slightly, primarily owing to construction of a permanent logging road that crossed streams. Changes in nutrient cycling occurred due to logging and slash disposal in both watersheds where cutting was done. NO3-N concentrations, which increased most where logging residue was left to decompose naturally, increased more than sixfold and commonly exceeded 100 micrograms/L during the October-June high-flow season for seven years after logging. Where logging slash was broadcast burned, NO3-N concentrations increased roughly fourfold, but rarely exceeded 50 micrograms/L, and increases had mostly disappeared six years after slash burning. Changes in outflows of cations and other anions were not apparent. Annual maximum stream temperatures increased 2-3 C after logging, but temperature increases had mostly disappeared within three years as vegetation regrowth shaded the streams. (Author's abstract)
W89-06067

HYDROLOGY AND SOIL FERTILITY OF DEGRADED GRASSLANDS AT CHERRAPUNJI IN NORTHEASTERN INDIA,
Jawaharlal Nehru Univ., New Delhi (India). School of Environmental Sciences.
S. C. Ram, and P. S. Ramakrishnan.
Environmental Conservation EVCNA4, Vol. 15, No. 1, p 29-35, 1988. 6 fig, 5 tab, 26 ref.

Descriptors: *Desertification, *Vegetation, *Grasslands, *India, *Fertility, *Soil water, Soil properties, Hydrology, Biomass, Environmental effects, Species composition, Land use, Monsoons, Nutrients, Soil stabilization, Soil moisture retention.

Four grassland types at Cherrapunji, in northeastern India, namely the Osbeckia, Arundinella, Ischaemum, and Eragrostiella, types, were studied for soil nutrient losses through their hydrology and related soil-fertility changes. Losses through water

and the subsequent soil-fertility depletion were shown to be related to the frequency of the burn to which these grasslands are subjected. The Ischaemum type, with regular burning at 2-years' intervals, was the most adversely affected, compared with the Osbeckia type, which had not been burnt for the past 6 years. In all the grassland types which were studied, the losses through water were high during the early monsoon period, owing to the poor vegetation cover at that time. A desertified site with the Eragrostiella type of grassland had the lowest soil-fertility level, and had losses through removal in water that far exceeded the prevailing soil-nutrient level. Fire can help in stabilizing the seral grassland vegetation if the soil is sufficiently deep and the frequency of the burn is not too great. On the other hand, too frequent perturbations by fire are apt to result in a desertified landscape that is difficult to restore. (Author's abstract)
W89-06158

'ECOSYSTEM' APPROACH TO MANAGING HUMAN USES AND ABUSES OF NATURAL RESOURCES IN THE GREAT LAKES BASIN,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
For primary bibliographic entry see Field 6A.
W89-06159

EFFECTS OF IRON COMPOUNDS ON MACROINVERTEBRATE COMMUNITIES IN A DANISH LOWLAND RIVER SYSTEM,
Water Board of Vejle Amtskommune (Denmark).
For primary bibliographic entry see Field 5C.
W89-06184

LANDSCAPE CHANGE IN THE LAKE SIMCOE-COUCHICHING BASIN, 1800-1983,
Montana State Univ., Bozeman. Dept. of Earth Sciences.
J. P. Wilson, and C. M. Ryan.
Canadian Geographer CNGGAR, Vol. 32, No. 3, p 206-222, 1988. 8 fig, 1 tab, 32 ref.

Descriptors: *Land use, *Lakes, *Soil erosion, *Agricultural watersheds, Vegetation effects, Environmental effects, Rainfall-runoff relationships, Crop production, Human population, Watershed management, Environmental quality.

Changes in erosive land uses since the Lake Simcoe-Couchiching Basin was first settled by Europeans were investigated. Information about environmental changes was provided by census data about agricultural land use, existing knowledge of people-environment relationships in terms of crop rotations employed at different times in this basin, cover and soil erosion captured by the universal soil loss equations's cover-management factor, and the potential erosive land use index (ELU). Findings not only confirm earlier assessments by other researchers that the early days of settlement were destructive, but they also show that the Lake Simcoe-Couchiching Basin, used in effect as a laboratory, has undergone huge environmental changes without efforts to form a permanent and more viable system of land use. Problems of conservation and renewal remain, exemplified by the increase in the farmland potential ELU index that has followed the increase in corn hectarage since 1961. The overall ELU index estimated for the 59% of the basin incorporated in farms and the 0.03 index assumed for the remaining 41% of the basin, is lower than in 1891 and other years only because a smaller proportion of the basin was used for agriculture. This result indicates the need for continued concern about the future productivity of human environments and their ability to yield resources and still remain wholesome to the human settler. A continued search for permanent and more viable systems of land use is recommended. (Geiger-PTT)
W89-06197

GRAZING EFFECTS ON STREAM HABITAT AND FISHES: RESEARCH DESIGN CONSIDERATIONS,
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
J. N. Rinne.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 2, p 240-247, Spring 1988. 4 fig, 1 tab, 45 ref.

Descriptors: *Aquatic habitat, *Stream biota, *Fishes, *Grazing, *Riparian vegetation, Experimental design, Stream banks, Fish populations, Fish management, Range management, Agricultural watersheds, New Mexico.

In 1982, a 4-year study began of a northern New Mexico montane stream that had been fenced to keep livestock from grazing the stream bank and adjacent vegetation for 10 years. The research objective was to determine if this 'exclusion' benefited riparian ecosystems. The factors that made this study difficult to interpret are discussed. The results indicated that stream-bank vegetation and stability were markedly improved and that stream-substrate fines were somewhat reduced, but that fish populations were unaffected. Shortcomings of this case-history study are common to past similarly-designed studies of grazing effects on fishes and their habitats. Three major deficiencies in research design are (1) lack of pretreatment data, (2) improper consideration of fishery-management principles, and (3) linear positioning of treatments along a stream. Cattle behavior patterns and the economics of altering such behavior favor future research on riparian grazing effects which address these factors in addition to designs of long-term (10+ years) ecosystem (watershed) studies. (Author's abstract)
W89-06288

CHANGES IN THE NORTH CHANNEL FISH COMMUNITY WITH EMPHASIS ON PINK SALMON (ONCORHYNCHUS GORBUSCHA WALBAUM),
Ontario Ministry of Natural Resources, Toronto. Lake Huron Fisheries Research Unit.
For primary bibliographic entry see Field 8I.
W89-06348

EFFECTS OF SALINITY AND WATERLOGGING ON THE VEGETATION OF LAKE TOOLIBIN, WESTERN AUSTRALIA,
Western Australia Univ., Nedlands. Dept. of Botany.
R. H. Froend, E. M. Heddle, D. T. Bell, and A. J. McComb.
Australian Journal of Ecology AJECDQ, Vol. 12, No. 3, p 281-298, September 1988. 9 fig, 20 ref.

Descriptors: *Land use, *Environmental effects, *Ephemeral lakes, *Trees, *Plant pathology, *Saline soils, *Groundwater level, *Waterlogging, Agriculture, Waterfowl, Wildlife conservation, Tree senescence, Mortality, Land clearing, Australia.

Increased rates of tree senescence and mortality in and adjacent to an ephemeral lake in the Western Australian wheatbelt have been attributed to increased levels of soil salinity and inundation following agricultural clearing. Winter lake salinities approximate freshwater lake values, but during periods when the lake is dry, capillary rise of groundwater is thought to increase surface soil salinity. An undescribed species of Melaleuca and Casuarina obesa dominated the seasonally inundated regions of the lake bed. Aeolian deposits of higher elevation were dominated by Eucalyptus loxophleba, Allocasuarina huegeliana or species of Banksia. Woodland of E. oleosa var. longicornis and E. salmonophloia occurred predominantly on upland fluviatile deposits of sand and sandy clays. Measurements of soil salinity and the calculation of percentage inundation from tree elevations and observations of tree vigor and xylem pressure potential response indicated that tree deaths in Melaleuca sp. and C. obesa were due to increased levels of salinity. Deaths and low vigors in E. rudis were attributed to both increasing salinities and prolonged inundation. Control of groundwater levels should be a major consideration in the preservation of this ephemeral lake and the water fowl populations it supports. (Author's abstract)
W89-06373

SUBSURFACE STORMFLOWS IN THE HIGHLY PERMEABLE FORESTED WATERSHEDS OF SOUTHWESTERN BRITISH COLUMBIA,
British Columbia Ministry of Forests and Lands, Kamloops. Research Section.
For primary bibliographic entry see Field 2G.
W89-06424

PALEOECOLOGICAL RECONSTRUCTION OF CHANGES IN THE PRODUCTIVITY OF A SMALL, MEROMICTIC LAKE IN SOUTHERN ONTARIO, CANADA,
Aquatic Research and Ecological Consultants, Mississauga (Ontario).
For primary bibliographic entry see Field 2H.
W89-06438

STREAMFLOW AND STREAM SALINITY IN A SMALL WATER SUPPLY CATCHMENT IN SOUTHWEST WESTERN AUSTRALIA AFTER REFORESTATION,
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 2E.
W89-06462

HYDROLOGICAL BEHAVIOUR OF THE NILGIRI SUB-WATERSHEDS AS AFFECTED BY BLUEGUM PLANTATIONS: PART I. THE ANNUAL WATER BALANCE,
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
For primary bibliographic entry see Field 2A.
W89-06463

HYDROLOGICAL BEHAVIOUR OF THE NILGIRI SUB-WATERSHEDS AS AFFECTED BY BLUEGUM PLANTATIONS: PART II. MONTHLY WATER BALANCES AT DIFFERENT RAINFALL AND RUNOFF PROBABILITIES,
Central Soil and Water Conservation Research and Training Inst., Dehra Dun (India).
For primary bibliographic entry see Field 2A.
W89-06464

FOREST CLEARCUTTING EFFECTS ON TRACE METAL CONCENTRATIONS: SPATIAL PATTERNS IN SOIL SOLUTIONS AND STREAMS,
State Univ. of New York Coll. at Plattsburgh. Center for Earth and Environmental Science.
R. D. Fuller, D. M. Simone, and C. T. Driscoll.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 185-195, 1988. 3 fig, 41 ref. NSF Grant BSR-8406634.

Descriptors: *Soil solution, *Streams, *Solute transport, *Forest management, *Environmental impact, *Clear cutting, *Trace metals, *Forest watersheds, Soil contamination, Acidic soils, Minerals, Path of pollutants, Spatial distribution, Soil chemistry.

Increased concentrations of solutes in drainage waters following forest clearcutting may affect downstream water quality. A study was performed to evaluate some of the processes regulating concentrations of trace metals and Fe in soil solutions and streamwater in a clearcut watershed by determining changes in metal release by soil horizon, stand vegetation and elevation. Commercial whole-tree harvesting of a watershed at the Hubbard Brook Experimental Forest, New Hampshire resulted in increased loss of NO3(-) from the study watershed. This NO3(-) loss resulted in acidification of soil solutions, which was associated with release of Mn and Zn from mineral soil to soil solutions and streamwater. Significant correlations of Pb and Fe with dissolved organic C (DOC) suggested that mobilization of these metals was linked to DOC transfer. However, there was little evidence of increased release of DOC, Fe, or Pb following the whole-tree harvest, except in a high

elevation spruce-fir zone with shallow soils. (Author's abstract)
W89-06491

COMPARISON OF IMPACTS ON MACROINVERTEBRATES AND FISH FROM GAS PIPELINE INSTALLATION BY WET-DITCHING AND PLOWING,
Argonne National Lab., IL. Energy and Environmental Systems Div.
W. S. Vinikour, J. P. Schubert, and D. K. Gartman.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-002893. Price codes: A02 in paper copy, A01 in microfiche. Report No. CONF-8710210--1, (1987). 10p, 4 fig, 3 tab, 23 ref. DOE Contract 5082-254-0690.

Descriptors: *Fish, *Ditches, *Macroinvertebrates, *Natural gas, *Pipelines, *Ecological effects, Environmental effects, Benthic environment, Invertebrates, Little Miami River, Ohio, Canada Creek, Michigan, Plowing.

Biotic effects from wet-ditching were investigated at the Little Miami River, Ohio. Invertebrate densities decreased at, and a short distance below, the crossing site; partial benthic recolonization occurred within three weeks of construction, while complete recolonization occurred within seven months. Fish recolonized the affected area within one month, but densities were reduced; within eight months after construction, the fish community was similar to that observed before construction. Biotic effects from the plow method were examined at Canada Creek, Michigan. No significant impacts on benthic macroinvertebrates were detected. During ramp excavation, increased macroinvertebrate drift densities were noted, as well as increased occurrence of terrestrial invertebrates in the drift; upon completion of ramp excavation, drift composition approximated that before construction. No effects on fish species were indicated. Overall, no biotic impacts were detected within three days after pipeline installation. (Author's abstract)
W89-06631

ALTERNATIVE BASIN CHARACTERISTIC FOR USE IN ESTIMATING IMPERVIOUS AREA IN URBAN MISSOURI BASINS,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06848

ANALYSIS OF CHARACTERISTICS OF SIMULATED FLOWS FROM SMALL SURFACE-MINED AND UNDISTURBED APPALACHIAN WATERSHEDS IN THE TUG FORK BASIN OF KENTUCKY, VIRGINIA, AND WEST VIRGINIA,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06861

POTENTIAL EFFECTS OF SURFACE COAL MINING ON THE HYDROLOGY OF THE CIRCLE WEST COAL TRACTS, MCCONE COUNTY, EASTERN MONTANA,
Geological Survey, Helena, MT. Water Resources Div.
M. R. Cannon.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4181, November 1984. 46p, 6 fig, 6 tab, 1 plate, 33 ref.

Descriptors: *Strip mines, *Land use, *Water table decline, *Coal mining, *Environmental effects, *Hydrology, *Montana, Groundwater budget, Hydraulic conductivity, Groundwater quality, Irrigation, Water quality, Sandstone.

The Circle West coal tracts in McCone County, Montana, contain about 460 million tons of recoverable coal reserves. Estimates of coal reserves for the tract are based predominantly on the S coal bed, which averages about 16 ft in thickness. About 175 million tons, or 38%, of the recoverable coal is Federally owned and has been identified for potential lease sale. A hydrologic study has been conducted in the potential lease area to describe existing hydrologic systems and to assess potential effects of surface coal mining on local water resources. Geohydrologic data collected from wells and drill holes indicate that shallow aquifers exist in sandstone and coal beds of the Tongue River Member of the Fort Union Formation (Paleocene age). These shallow aquifers generally have small values of hydraulic conductivity (0.1 to 380 ft/day) and typically yield from 2 to 20 gal/min to stock and domestic wells. Where coal is extremely fractured or the thickness of saturated sandstone is large, some wells can yield in excess of 70 gal/min. Chemical analyses indicate that most shallow aquifers contain a sodium sulfate bicarbonate type water. Surface water resources of the area consist of intermittent streamflow in parts of the Nelson and Timber Creek basins plus a large network of reservoirs. The reservoirs provide a large part of the water supply for area livestock and irrigation. Water quality data for Nelson and Timber Creeks indicate that the water generally is a sodium sulfate type and has a large concentration (181 to 6,960 mg/L) of dissolved solids. Mining of the S coal bed in the Circle West coal tracts would permanently remove shallow coal and sandstone aquifers, resulting in the loss of shallow stock wells. Mining would destroy livestock reservoirs, alter runoff characteristics of Nelson Creek, and temporarily lower water levels in shallow aquifers near the mine. Leaching of soluble constituents from mine spoils may cause a long-term degradation of the quality of water in shallow aquifers in and near the coal tracts. Some of the effects on local water supplies could be mitigated by development of alternative water resources in deeper aquifers such as the Tullock aquifer of Paleocene age and the Fox Hills-lower Hell Creek aquifer of Late Cretaceous age. (Author's abstract)
W89-06863

IMPACT OF THE PROPOSED I-326 CROSSING ON THE 500-YEAR FLOOD STAGES OF THE CONGAREE RIVER, NEAR COLUMBIA, SOUTH CAROLINA,
Geological Survey, Columbia, SC. Water Resources Div.
C. S. Bennett.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4280, 1984. 23p, 6 fig, 3 tab, 3 plates, 13 ref.

Descriptors: *Highway effects, *Flood forecasting, *South Carolina, *Design Flood, *Model studies, *Flood storage, *Flood plain, *Finite element method, Water level, Flood spreading, Flow velocity, Simulation analysis, Model studies, Hydraulic models, Surface waters.

A two-dimensional finite-element surface water flow modeling system based on the shallow water equations was used to study the hydraulic impact of the proposed Interstate crossing on the 500-year flood. Infrared aerial photography was used to define regions of homogeneous roughness in the flood plain. Finite-element networks approximating flood plain topography were designed using elements of three roughness types. High water marks established during an 8-year flood that occurred in October 1976 were used to calibrate the model. The 500-year flood (630,000 cu ft/sec) was simulated using the dike on the left bank as the left boundary and the right edge of the flood plain as the right boundary. Simulations were performed without and with the proposed highway embankments in place. Detailed information was obtained about backwater effects upstream from the proposed highway embankments, changes in flow distribution resulting from embankments, and velocities in the vicinity of the bridge openings. The results of the study indicate that the four bridge openings in the right flood plain should be adequate to handle the 500-yr flood flow. Forty percent of the flow passes through the main channel bridge, while the remaining 60% of the flow passes through the three overflow bridges. Average velocities in the bridge openings ranged from 3.4 ft/sec to 6.9 ft/sec with a maximum vertically averaged velocity of 9.3 ft/sec occurring at the right edge of one of the overflow bridges. (Author's abstract)
W89-06872

EFFECTS OF COAL MINE DRAINAGE ON THE WATER QUALITY OF SMALL RECEIVING STREAMS IN WASHINGTON, 1975-77,
Geological Survey, Tacoma, WA. Water Resources Div.
F. A. Packard, E. L. Skinner, and L. A. Fuste.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 85-4274, 1988. 65p, 25 fig, 10 tab.

Descriptors: *Water quality, *Mine drainage, *Washington, Small streams, Water chemistry, Biology, Monitoring.

Drainage from abandoned coal mines in western and central Washington has minimal environmental impact. Water quality characteristics that have the most significant environmental impact are suspended sediment and turbidity. Water quality data from 51 abandoned coal mines representing 11 major coal bearing areas indicate that less than 1% of the mine drainage has a pH of 4.5 or less. Fifty percent of the drainage is alkaline and has pH 7.0 and greater, and about 95% of the drainage has pH 6.0 and greater. Less than 2% is acidified to a pH of 5.6, a point where water and free (atmospheric) carbon dioxide are in equilibrium. The area where pH 5.6 or less is most likely to occur is in the Centralia/Chehalis mine district. No significant difference in diversity of benthic organisms was found between stations above and below the mine drainage. However, within the 50-ft downstream reach ostracods were more abundant than above the mine drainage and mayflies, stoneflies, and caddisflies were less abundant than at the control site. Correlations to water quality measurements show that these faunal changes are closely associated with iron and sulfate concentrations. (USGS)
W89-06882

FLOOD HYDROLOGY NEAR FLAGSTAFF, ARIZONA,
Geological Survey, Flagstaff, AZ. Water Resources Div.
For primary bibliographic entry see Field 2A.
W89-06886

GROUNDWATER WITHDRAWALS AND LAND SURFACE SUBSIDENCE IN THE HOUSTON-GALVESTON REGION, TEXAS, 1906-80,
Geological Survey, Houston, TX. Water Resources Div.
R. K. Gabrysch.
Available from Books and Open File Report Section, USGS, Box 25425, Denver CO 80225. Texas Department of Water Resources Report 287, 1984. 64p, 40 fig, 1 tab, 12 ref.

Descriptors: *Texas, *Subsidence, *Land subsidence, *Water level fluctuations, Artesian pressure, Compressibility, Extensometers, Piezometers, Withdrawal, Groundwater pumpage, Tide records, Houston-Galveston area.

The withdrawal of large amounts of groundwater in the Houston-Galveston region, Texas, has resulted in water level declines of as much as 250 ft in wells completed in the Chicot aquifer and as much as 300 ft in wells completed in the Evangeline aquifer during 1943-77. Since late 1976, changes in pumping distribution resulting from efforts to control subsidence and the introduction of surface water from Lake Livingston have altered the pattern of water level changes. In the Johnson Space Center and Baytown-La Porte areas (Chicot aquifer), and in the Pasadena area (Evangeline aquifer), water levels rose about 20 ft during 1973-77. However, in the western Houston area (Evangeline aquifer), water levels have continued to decline at an increasing rate through 1977. The declines in water levels have caused pronounced regional sub-

sidence of the land surface. The center of regional subsidence is the Pasadena area, where more than 9 ft and possibly as much as 10 ft of subsidence occurred between 1906 and 1978. Almost 9 ft of subsidence occurred between 1943 and 1978. Localized centers of subsidence exist throughout the region, especially in the Baytown-La Porte and Texas City areas. Evaluation of tide records from five gages in Galveston Bay and the tidal reaches of Buffalo Bayou indicates that changes in elevations of significantly less than 0.5 ft and possibly as little as 0.1 ft can be detected. The unit measure of compressibility, specific-unit compaction, ranged from 0.00001 to 0.00004 ft compaction/ft of clay thickness/ft of average water level change for 1906-78. The greatest compressibility was at the Clear Lake site and the least compressibility was at the Lake Houston site. The data indicate that the compressibility is related to the age of the sediments and the depth of burial of the sediments. (USGS)
W89-06916

SEDIMENT AND PHOSPHORUS LOAD TO STREAMFLOW FROM NATURAL AND DISTURBED WATERSHEDS IN NORTHEASTERN MINNESOTA,
Minnesota Univ., Minneapolis. Graduate School.
J. H. Leete.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8703411. Ph.D. Dissertation, 1986. 137p, 47 fig, 26 tab, 157 ref, append.

Descriptors: *Phosphorus, *Sediment load, *Lake sediments, *Logging, *Suspended sediments, *Water pollution sources, Lumber industry, Industrial waste, Streamflow, Streambeds, Clear-cutting, Storm runoff, Erosion, Forest watersheds, Watershed management, Minnesota.

The impacts of logging on sediment and phosphorus export from watersheds along the north shore of Lake Superior were studied to determine the relationships between streamflow rate and suspended sediment concentration before and after logging, between suspended sediment concentration and total and soluble phosphorus concentrations in streamflow, and between the phosphorus content of soils on the watershed and the phosphorus content of streambed sediments before and after logging. A total of 4% and 47% of the forest was clearcut in 142 and 26 hectare treatment watersheds, respectively. Two years post-harvest, peak discharge, average daily runoff, total runoff, and baseflow from the 47% clearcut watershed increased. Road construction had a dominating impact on the 4% clearcut watershed; the obstruction decreased peak flows and stormflow volumes. Analysis of the watershed's soils and stream-channel sediments revealed more rapid erosion after the harvest. Post-treatment sediment and phosphorus export was increased yet remained within the range of values expected from undisturbed forested watersheds. (Cremmins-AEPCO)
W89-06965

4D. Watershed Protection

BALTIC EUROPE, GREAT LAKES AMERICA AND ECOSYSTEM REDEVELOPMENT,
Gdansk Univ. (Poland). Dept. of Economic Geography of the Sea.
For primary bibliographic entry see Field 6G.
W89-06163

IMPORTANCE OF THE NEARSHORE AREA FOR SUSTAINABLE REDEVELOPMENT IN THE GREAT LAKES WITH OBSERVATIONS ON THE BALTIC SEA,
Wisconsin Univ.-Green Bay. Inst. for Land and Water Studies.
For primary bibliographic entry see Field 6A.
W89-06164

INSTITUTIONS AND ECOSYSTEM REDEVELOPMENT IN GREAT LAKES AMERICA WITH REFERENCE TO BALTIC EUROPE,
Waterloo Univ. (Ontario). Dept. of Environment and Resource Studies.
For primary bibliographic entry see Field 6E.
W89-06165

LANDSCAPE CHANGE IN THE LAKE SIMCOE-COUCHICHING BASIN, 1800-1983,
Montana State Univ., Bozeman. Dept. of Earth Sciences.
For primary bibliographic entry see Field 4C.
W89-06197

5. WATER QUALITY MANAGEMENT AND PROTECTION

5A. Identification Of Pollutants

EVALUATION OF SEVERAL SELECTIVE MEDIA FOR RECOVERY OF AEROMONAS HYDROPHILA FROM POLLUTED WATERS,
Malaga Univ. (Spain). Dept. of Microbiology.
M. L. Arcos, A. de Vicente, M. A. Morinigo, P. Romero, and J. J. Borrego.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2786-2792, November 1988. 1 fig, 9 tab, 39 ref.

Descriptors: *Bacterial identification, *Sampling, *Culture media, *Isolation, *Aeromonas, *Culturing techniques, *Microbiological studies, Agars, Water pollution.

Eleven media were studied for their suitability in the selective isolation of Aeromonas hydrophila. Preliminary results showed that five of them (inositol-brilliant green-bile salts agar, bile salts-brilliant green agar, Rimler-Shotts agar, xylose-sodium deoxycholate-citrate agar, and dextrin-fuchsin-sulfite agar) allowed the growth of several microorganisms that are usually present in the same samples in which A. hydrophila is found. Six media (mA agar, modified Rimler-Shotts agar, DNase-toluidine blue-ampicillin agar, Pril-xylose-ampicillin agar, MacConkey-trehalose agar, and starch-bile salts agar) were selected for evaluation as recovery selective media on the basis of their efficiency in the isolation of A. hydrophila from natural water samples. mA agar showed the best recovery rate and also an acceptable specificity, but its selectivity was low. Another medium that can be considered is DNase-toluidine blue-ampicillin agar, which showed good accuracy, but its specificity was low. (Author's abstract)
W89-05796

DIRECT VIABLE COUNTING METHOD FOR MEASURING TOLERANCE OF AQUATIC MICROBIAL COMMUNITIES TO HG(2+),
Technology Applications, Inc., Gulf Breeze, FL.
For primary bibliographic entry see Field 7B.
W89-05814

EXTRACTION AND SOLID PHASE CLEANUP METHOD FOR PESTICIDES IN SEDIMENT AND FISH,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
L. K. Marble, and J. J. Delfino.
American Laboratory ALBYBL, Vol. 20, No. 11, p 23-24, 26, 28, 30, 32, November 1988. 2 fig, 5 tab, 11 ref. Florida Dept. of Environmental Regulation Contract WM144.

Descriptors: *Pollutant identification, *Pesticides, *Sediments, *Fish, *Cleanup, Halogenated pesticides, Organophosphorus pesticides, Solvents, Optimization, Sample preparation, Gas chromatography, Detection limits, DDT, Lindane, Dieldrin, Reagents, Catfish.

The solid-phase extraction technique was studied as applied to the cleanup and analysis of organochlorine and organophosphorus pesticides present in sediment and fish tissue. Pesticides used were lindane, chlorpyrifos, dieldrin, DDE, and DDT. Experimental variables evaluated include: (1) selection of an optimum SPE column packing material; (2) optimization of sample extract volume, column elution solvent, and elution solvent volume; (3) optimization of the extraction technique; (4) sample matrix; (5) sample storage and temperature; and (6) comparison of pesticide recoveries from fish and sediment using the same extraction method. The proposed method involves simplified procedures and saves solvent, materials, and time. Pesticide recoveries either met or exceeded those reported in the literature for similar analytes and matrices. It is concluded that the procedural efficiency and ease of use make this method suitable for laboratories that must screen and analyze large numbers of samples rapidly. (Doria-PTT)
W89-05815

PHAGE F2 DESORPTION FROM CLAY IN ESTUARINE WATER USING NONIONIC DETERGENTS, BEEF EXTRACT, AND CHAOTROPIC AGENTS,
Rhode Island Univ., Kingston. Dept. of Microbiology.
R. Armon, and V. J. Cabelli.
Canadian Journal of Microbiology CJMIA2, Vol. 34, No. 8, August 1988. 2 fig, 2 tab, 12 ref.

Descriptors: *Estuarine environment, *Sorption, *Pollutant identification, *Bacteriophage, *Bioindicators, *Microbiological studies, *Clays, Sediments, Reagents, Enteroviruses, Infection.

Coliphages have been suggested to be reliable indicators for the presence of enteric viruses in water, because their size, morphology, and composition resemble that of the enteric viruses. However, some bacteriophages found in environmental waters are adsorbed to clay particles and are unable to infect their bacterial host; the F2 male-specific phage is an example. Experimentally adsorbed bacteriophage F2 was eluted from clay particles in estuarine water using 1% Tween, 80.3% beef extract, and 0.3 M $NaNO_3$ with 54% recovery. Replacing sodium nitrate with tetrasodium pyrophosphate (0.4 M) increased the recovery to 81%. Estuarine sediments treated with 1% Tween 80 revealed significantly higher male-specific phage elutions. (Brock-PTT)
W89-05871

CALIFORNIA TEAM STUDY: BREATH CONCENTRATIONS AND PERSONAL EXPOSURES TO 26 VOLATILE COMPOUNDS IN AIR AND DRINKING WATER OF 188 RESIDENTS OF LOS ANGELES, ANTIOCH, AND PITTSBURG, CA,
Environmental Protection Agency, Washington, DC.
L. A. Wallace, E. D. Pellizzari, T. D. Hartwell, R. Whitmore, and H. Zelon.
Atmospheric Environment ATENBP, Vol. 22, No. 10, p 2141-2163, October 1988. 8 fig, 26 tab, 17 ref. EPA Cooperative Agreement CR-812667-01-0.

Descriptors: *Population exposure, *Respiration, *Pollutant identification, *Drinking water, *Air pollution, *California, *Volatile organic compounds, Aromatic compounds, Aliphatic hydrocarbons, Chlorinated hydrocarbons, Breath sampling, Toxins.

The U.S. Environmental Protection Agency carried out a study of personal exposures to 26 volatile organic chemicals in the air, drinking water, and exhaled breath of 188 California residents in 1984. Sixteen chemicals were often found above quantifiable limits in the personal air samples, but only the 4 trihalomethanes were often found in drinking water. The highest exposures were to 1,1,1-trichloroethane, para-dichlorobenzene, xylenes, benzene, and tetrachloroethylene. Indoor air concentrations generally exceeded outdoor air concentrations, particularly at the higher percentiles. Breath concentrations of 8 chemicals showed significant correlations with preceding personal air concentrations in the 2 visits to Los Angeles. Smoking, employment, and automobile-related activities were identified as important sources of personal exposure to a number of target compounds. (Author's abstract)

W89-05914

MODIFIED PURGE-AND-TRAP/GAS CHROMATOGRAPHY METHOD FOR ANALYSIS OF VOLATILE HALOCARBONS IN MICROBIOLOGICAL DEGRADATION STUDIES,
Northrop Services, Inc., Ada, OK.
J. W. Cochran, M. V. Yates, and J. M. Henson.
Journal of Microbiological Methods JMIMDQ, Vol. 8, No. 6, p 347-354, November 1988. 4 fig, 1 tab, 21 ref. EPA Contract G8-03-3315.

Descriptors: *Chemical analysis, *Microbial degradation, *Hydrocarbons, *Fate of pollutants, *Microbiological studies, *Gas chromatography, Methane bacteria, Purge-and-trap unit, Halocarbons, Water pollution, Aerobic digestion, Aliphatic hydrocarbons.

Recent studies show that stimulation of naturally-occurring microorganisms can by the addition of methane or other gaseous alkanes, result in the aerobic degradation or removal of many of the aliphatic halogenated hydrocarbons (halocarbons). A modification of a purge-and-trap unit is described for use in microbiological studies concerning degradation of halocarbons. Sealed serum tubes containing bacteria, aqueous medium, headspace, and volatile halocarbons are used as purge vessels to monitor the disappearance of the halocarbons. Transfer from sample container to syringe does not occur; therefore losses caused by manipulation are eliminated. Data are presented to show the loss of volatile hydrocarbons that occurred when these systems were analyzed by the standard purge-and-trap. An application of this method is shown with methane-utilizing bacteria. The modified purge-and-trap method resulted in a total measurement of halocarbons in the sample. (Author's abstract)
W89-05943

NOVEL METHOD FOR LIBERATING VIRAL NUCLEIC ACID FOR ASSAY OF WATER SAMPLES WITH CDNA PROBES,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
K. J. Richardson, A. B. Margolin, and C. P. Gerba.
Journal of Virological Methods JVMEDH, Vol. 22, No. 1, p 13-21, October 1988. 2 fig, 2 tab, 12 ref.

Descriptors: *Drinking water, *Bioassay, *Viruses, *Assay, *Water quality, Enteroviruses, Heat treatment, Model studies, Poliovirus, Enzymes, Inhibition.

Rapid and sensitive methods are needed for the detection of enteric viruses to ensure proper drinking water quality. Gene probes have been shown to be useful for this purpose. Previously, samples to be assayed were treated with a series of phenol-chloroform extractions to release the viral nucleic acid. A more rapid procedure for liberating or exposing the genome of poliovirus for probing was developed. In this study, a poliovirus model was used to test the ability of heat (65 C for 30 min) to release or expose viral nucleic acid. Several different RNase inhibitors were tested for their ability to prevent viral RNA degradation. A comparison of the two methods indicates phenol-chloroform extraction is not necessary before probing. In addition to saving 2-4 h of time, maximum sensitivity levels were consistently obtained using this novel procedure. (Author's abstract)
W89-05944

ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER BY DYNAMIC STRIPPING, THERMAL DESORPTION, CRYOFOCUSING, AND CAPILLARY GAS CHROMATOGRAPHY,
Northrop Services, Inc., Ada, OK.
S. A. Vandegrift.
Journal of Chromatographic Science JCHSBZ, Vol. 26, No, 10, p 513-516, October 1988. 3 fig, 6 tab, 17 ref. EPA Contract 68-03-3315.

Descriptors: *Gas chromatography, *Water analysis, *Pollutant identification, *Organic compounds, Cryofocusing, Thermal desorption, Dynamic stripping, Adsorbents, Aromatic compounds, Quantitative analysis, Calibrations, Water quality standards.

A dynamic headspace procedure for the determination of volatile organic compounds in water is described. The volatile organic compounds are purged from a water sample with an inert gas, transferring them to a tube packed with Tenax adsorbent. The absorbent tube, or trap, is thermally desorbed, the analytes cryofocused, and subsequently transferred to a capillary column gas chromatograph. Two sets of samples at two different concentration levels were included. One set was for volatile aromatics analysis, the other for volatile halocarbon analysis. Quantification was determined by using an internal standard calibration. Almost all (except for bromoform) of the reported values agree well with the true values and are well within the EPA acceptance limits. (Miller-PTT)
W89-05945

SPECTROPHOTOMETRIC CATALYTIC DETERMINATION OF AN ULTRATRACE AMOUNT OF IRON(III) IN WATER BASED ON THE OXIDATION OF N,N-DIMETHYL-P-PHENYLENEDIAMINE BY HYDROGEN PEROXIDE,
Nihon Univ., Tokyo. Dept. of Industrial Chemistry.
K. Hirayama, and N. Unohara.
Analytical Chemistry ANCHAM, Vol. 60, No. 23, p 2573-2577, Dec 1 1988. 4 fig, 6 tab, 36 ref.

Descriptors: *Trace levels, *Water analysis, *Chemical analysis, *Iron, *Catalysts, *Spectrophotometry, *Pollutant identification, Hydrogen peroxide, Detection limits, Chemical reagents, Oxidation.

Recently there has been an increasing need for a highly-sensitive method of analysis for iron in water surveys and in environmental and biochemical studies. A catalytic method for determining an ultratrace amount of iron(III) is based on the catalytic action of iron(III) on the oxidation of N,N-dimethyl-p-phenylenediamine by hydrogen peroxide in weakly acidic media. The catalyzed reaction was monitored spectrophotometrically at 514 nm by the fixed time method. It is shown that it is possible to determine iron as low as 0.2 ng/L without an activator. Since the fixed time method could be employed for monitoring the reaction rate, only 5 min was required for the absorbance measurement, and five successive determinations were performed within 10 min with a simple and rapid operation. Although a low blank value of less than 0.05 was attained if the reagent blank could be reduced further by purifying the reagent solutions, it seems that the sensitivity can be elevated 1 order of picograms per milliliter as compared to previous methods. This is because the reaction can be followed at a higher temperature (>25 C). The flow injection analysis arrangements, that will provide a simultaneous detection and an automatic sample feeding, will be explored. (Miller-PTT)
W89-05950

QUANTITATIVE DETERMINATION OF TRACE LEVELS OF CATIONIC SURFACTANTS IN ENVIRONMENTAL MATRICES USING FAST ATOM BOMBARDMENT MASS SPECTROMETRY,
Procter and Gamble Co., Cincinnati, OH. Miami Valley Labs.
J. R. Simms, T. Keough, S. R. Ward, B. L. Moore, and M. M. Bandurraga.
Analytical Chemistry ANCHAM, Vol. 60, No. 23, p 2613-2620, Dec 1 1988. 5 fig, 4 tab, 66 ref.

Descriptors: *Quantitative analysis, *Water analysis, *Trace levels, *Mass spectrometry, *Surfactants, *Pollutant identification, Wastewater, Rivers, Fast atom bombardment mass spectrometry, Water pollution, Variation coefficient, Detection limits, Reproducibility, Radioactivity techniques.

Two fast atom bombardment mass spectrometry methods were evaluated for the quantification of parts-per-billion levels of cationic surfactants in aqueous environmental matrices including sewage influents, sewage effluents, and river water. The first method, low-resolution full scanning, allows the simultaneous quantification of targeted components. The second, higher resolution signal averaging, is more accurate and reproducible than full scanning but allows quantification of only a single component at a time (with existing software). Average recoveries of theoretical spike, over the concentration range of 10 to 500 ppb, varied from 86 to 107% depending upon the method used. The coefficients of variation averaged 5 to 14%. Fast atom bombardment mass spectrometry has a limit of quantification that is 1 to 2 orders of magnitude lower than existing chromatographic techniques and sample throughput is, conservatively, 5 times higher. A potential limitation of this method is the requirement of suitable, preferably stable-isotope labeled, internal standards. (Author's abstract)
W89-05951

ELECTRON MICROSCOPY OF NANOMETER PARTICLES IN FRESHWATER,
Nagoya Univ. (Japan). Faculty of Engineering.
For primary bibliographic entry see Field 2K.
W89-05952

IDENTIFICATION OF OIL SPILLED AT SEA BY HIGH PERFORMANCE GEL PERMEATION CHROMATOGRAPHY PATTERN RECOGNITION,
Government Industrial Research Inst., Osaka, Ikeda (Japan).
K. Higashi, and K. Hagiwara.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 55-62, 1988. 10 fig, 3 tab, 5 ref.

Descriptors: *Oil characterization, *Oil spills, *Pollutant identification, *Chromatography, Water pollution sources, Pattern recognition, Marine environment, Chemical composition, Japan, Oil pollution, Conservation, Ultraviolet radiation, Computers.

Oil pollution in the marine environment has now become a world-wide concern. Recently, in Japan, over 1,000 cases of oil pollution have been occurring every year. It is important to develop an effective identification method for spilled oils for conservation of marine environments. A new method was developed using high performance gel permeation chromatography (GPC). Chromatograms of the molecular weight distribution of oils were obtained using an ultra-violet (UV) detector. Pattern similarities between pairs of chromatograms were calculated by section areas of the chromatograms using a computer. Sixty-two kinds of crude oil imported by Japan were classified by this method, and a close relationships were found between the countries of origin of the crude oils and their chromatographic patterns. Forty nine tar balls sampled from Japanese coasts were compared with the crude oils, and the origins of the tar balls were deduced. The proposed method was effective for the identification of spilled oils, and had high sensitivity and reproducibility. (Author's abstract)
W89-06020

MEDIA EVALUATION AND BEHAVIOR OF CLOSTRIDIUM PERFRINGENS AS AN ADJUNCT INDICATOR OF QUALITY IN SHELLFISH GROWING AREAS,
Food and Drug Administration, Seattle, WA. Seafood Products Research Center.
C. Abeyta, M. M. Wekell, C. A. Kaysner, R. F. Stott, and E. V. Raghubeer.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 63-70, 1988. 2 fig, 5 tab, 22 ref.

Descriptors: *Culture media, *Clostridium, *Shellfish, *Bioindicators, Estuaries, Oysters, Bacterial analysis, Coliforms, Iron Milk Method, Bacteria, Contamination, Streptococcus, Sediments, Raw wastewater, Cultural techniques.

In numerous studies of estuaries of the West Coast of the United States, C. perfringens have been recovered, total and fecal coliforms, and fecal streptococci from shellfish, sediments and water.

In some areas closed to shellfish harvest and known to be subject to fecal contamination, C. perfringens were recovered regularly from shellfish and sediments. For example, in one estuary, prior to sampling, a local sewage treatment plant (STP) with a design capacity of 1 million gallons per day (MGD) was receiving high flows of raw sewage of 3.02 MGD. This resulted in an overflow or bypass of raw sewage into the estuary. Fecal coliform and fecal streptococci levels measured in impacted oysters showed an increase during the initial stages of the bypass and decreased to baseline levels by the 5th day of sampling. C. perfringens levels increased from 36 MPN/100 g and reached maximum levels in oysters (4600 MPN/100 g) on the 6th day when the sewage flow was returning to normal, but still over capacity (1.8 MGD) and sewage was being discharged into the baseline levels (120 and 50 organisms/100 g respectively). Therefore, at the later stages of the sewage bypass, C. perfringens was a useful indicator of fecal contamination in oysters. The most recent and promising method for enumeration of C. perfringens in all types of environmental samples is the Iron Milk Method (IMM). The method has been shown to enumerate C. perfringens without the need for confirmation. The IMM uses a 3 tube MPN procedure with each tube containing 10 mL of homogenized milk plus 0.2 g iron powder per tube. Inoculated tubes are incubated and the presence of the classical stormy fermentation signifies a positive tube. Numbers of C. perfringens in samples are rapidly measured. (Author's abstract)
W89-06021

TOXIC CHEMICAL POLLUTION OF THE ST. LAWRENCE RIVER (CANADA) AND ITS UPPER ESTUARY,
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
For primary bibliographic entry see Field 5B.
W89-06023

INTRODUCTION: AQUATIC ORGANISMS AS INDICATORS OF ENVIRONMENTAL POLLUTION,
National Marine Fisheries Service, Miami, FL. Southeast Fisheries Center.
J. A. Browder.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 927-929, October 1988.

Descriptors: *Bioindicators, *Estuarine environment, *Water pollution effects, *Reviews, Aquatic life, Pathology, Marine environment, Fish diseases, Environmental effects.

The streams, lakes, and estuaries that receive our nation's wastewater and runoff are the habitat of fish and other aquatic organisms. The health of these organisms is a direct reflection of the quality of aquatic habitat. Ten papers, most of which were presented in a session of the International Conference of the American Water Resources Association, November 1986, are briefly described. Most of these provide details on one of six general categories of biological indicators: (1) pathological; (2) biochemical; (3) physiological; (4) genetic; (5) behavioral; and (6) ecological. The papers have presented demonstrable evidence of the effect of major categories of pollutants on aquatic systems, and have shown how effects of pollutants on the environment are being - and can be - monitored. Water quality monitoring programs might benefit from the use of biological indicators, in addition to chemical ones. (VerNooy-PTT)
W89-06046

BIOLOGICAL INDICATORS AND BIOLOGICAL EFFECTS OF ESTUARINE/COASTAL POLLUTION,
National Marine Fisheries Service, Oxford, MD. Northeast Fisheries Center.
C. J. Sindermann.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 931-939, October 1988. 3 fig, 70 ref.

Descriptors: *Coastal waters, *Bioindicators, *Estuarine environment, *Water pollution effects, Literature review, Reviews, Pathology, Ecological effects, Marine environment, Fish diseases.

Sustained interest in and concern about the health status of the aquatic environment has resulted in extensive research focused on (1) effects of pollution on survival, growth, and reproduction of resource species at all life stages; (2) diseases of fish and shellfish, as they may be related to pollution and as they may serve as indicators of environmental stress; and (3) contaminant body burdens in fish and shellfish--their effects on the aquatic animals and their potential effects on humans. Effects, lethal and sublethal, of pollutants on life history stages of fish and shellfish have been documented, as have impacts on local stocks in badly degraded habitats, but as yet there has been no adequate quantitative demonstration of effects on entire aquatic species--probably because of the difficulty in sorting out relative effects of the many environmental factors that influence abundance. Sublethal effects, especially those that result in disease, have been examined intensively, and some diseases and disease syndromes have been associated statistically with pollution. Other pollution indicators (biochemical, physiological, genetic, behavioral, and ecological) have also received some attention, as have body burdens of contaminants in aquatic species. Research, especially that conducted during the past decade, has done much to clarify the many pathways and toxic effects of contaminants on aquatic animals, and has also helped to identify mechanisms for survival of fish and shellfish in the presence of environmental changes caused by human activities. (Author's abstract)
W89-06047

SMALL FISH MODELS FOR IDENTIFYING CARCINOGENS IN THE AQUEOUS ENVIRONMENT,
Gulf Coast Research Lab., Ocean Springs, MS.
W. E. Hawkins, R. M. Overstreet, and W. W. Walker.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 941-949, October 1988. 6 fig, 43 ref. Public Health Service Contract N01-CP-26008/61070.

Descriptors: *Water pollution effects, *Fish, *Bioassay, *Fish diseases, *Carcinogens, *Toxicity, Reviews, Animal pathology, Model testing, Sublethal effects.

Contaminants in water and sediments can be carcinogenic to aquatic wildlife as well as humans. Identifying those carcinogens, however, is difficult because they often occur in low concentrations and exert their effects over a large part of the life span of affected organisms. Furthermore, the carcinogens are often components of complex mixtures. Recent studies suggest that laboratory-reared fish species might be well suited for testing water-associated and other carcinogens. The principal carcinogen exposure methods that utilize small fish species or can be adapted to utilize small fish species to detect carcinogens in aqueous environments are reviewed. Emphasis is placed on methods for which the end-point is tumor induction. The methods discussed are dietary exposures, skin painting, embryo microinjection, early life stage (pulse) exposures, static water exposures, flow-through exposures, and controlled field exposures. Early life stage exposures seem to have the greatest utility with regard to carcinogen sensitivity, ease of administration, disposal of test compounds, and economy of materials and effort. For certain types of carcinogens, however, long-term flow-through exposures are probably required. Small fish carcinogenesis models offer an array of methodologies that can be utilized in a variety of combinations depending on compounds tested, exposure parameters employed, and end points sought. (Author's abstract)
W89-06048

CAGED FISH AS MONITORS OF POLLUTION: EFFECTS OF CHLORINATED EFFLUENT FROM A WASTEWATER TREATMENT PLANT,
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
J. M. Grizzle, S. A. Horowitz, and D. R. Strength.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 951-959, October 1988. 2 fig, 4 tab, 29 ref. NCI-EPA Collaborative Program, Project No. 3, Cooperative agreements CR8093360100 and CR809673010.

Descriptors: *Bioindicators, *Wastewater treatment, *Chlorine, *Fish, *Water pollution effects, *Effluents, Wastewater pollution, Monitoring, Animal pathology, Bullhead, Catfish, Carcinogens.

Fish confined to cages were used to determine the effects of effluent from a wastewater treatment plant (WWTP). Control fish were kept in cages in an aquaculture pond. Acute effects of the effluent entering the final oxidation pond of the WWTP were determined by confining channel catfish (Ictalurus punctatus) at the pond inlet; the mean total residual chlorine (TRC) concentration was 0.9 mg/L during this exposure. After 8 h, 42% of the fish had died and survivors had severe lesions of the skin and gills. During the first two weeks of exposure, channel catfish at the outlet of the final oxidation pond (mean TRC = 0.1 mg/L) were predisposed to bacterial infection but lost the parasitic trematodes that were on the gills when the fish were placed in cages. After several weeks, exposed fish had histologic lesions, enlarged livers, and reduced growth. The presence of unidentified carcinogen(s) in the effluent of this WWTP was indicated by papillomas developing on caged black bullheads (Ictalurus melas) and hepatic-enzyme induction in channel catfish. In situ, exposure of caged fish was advantageous because storage and pretreatment of water samples were not required, and exposure levels corresponded to those present in the environment. The use of cages for containment of fish during field exposure allowed confinement to the location of interest and convenient sampling of the fish. Unlike wild fish, the caged fish could be compared to control fish with the same pre-exposure history. (Author's abstract)
W89-06049

FISH TUMORS AND ECOLOGICAL SURVEILLANCE: A CAUTIONARY EXAMPLE FROM PORT PHILLIP BAY,
British Industrial Biological Research Association, Carshalton (England).
For primary bibliographic entry see Field 5C.
W89-06052

EFFECT OF BIOLOGICAL VARIABILITY ON MONITORING STRATEGIES: METALLOTHIONEINS AS AN EXAMPLE,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
D. W. Engel.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 981-986, October 1988. 5 fig, 2 tab, 24 ref.

Descriptors: *Bioindicators, *Metallothionein, *Model testing, *Monitoring, *Metabolism, *Metals, *Estuarine environment, Variability, Oysters, Whales, Crabs, Bioaccumulation, Environmental effects.

An increasing need exists to determine the relative health of estuarine and coastal systems with respect to their ability to support populations of fishery organisms. Many monitoring programs developed for this purpose utilize physiological and biochemical techniques to determine if marine organisms are stressed by contaminant exposure. The use of the low molecular weight, metal-binding protein, metallothionein, is used as a model technique to detect nonlethal stress in aquatic organisms. Test organisms were the American oyster, Crassostrea virginica, the blue crab, Callinectes sapidus, and the beaked whale, Mesoplodon europaeus. The data illustrate how natural environmental and physiological factors can affect the mobilization and partitioning of metal by organisms and contribute to observed variability in data sets. The processes that affected trace metal partitioning and accumulation were: in oysters, the reproductive cycle/season of the year; in blue crabs, growth and the molt cycle; and in the whale, the type of food and habitat. To monitor populations of fishery organisms effectively, therefore, it is necessary to identify those factors that control survival, growth, and reproduction so that better predictive models can be formulated that will not be con-

founded by uncontrolled variables. (Author's abstract)
W89-06053

CORRELATION OF COPROSTANOL TO ORGANIC CONTAMINANTS IN COASTAL AND ESTUARINE SEDIMENTS OF THE U.S.,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
For primary bibliographic entry see Field 5B.
W89-06054

FISH EMBRYOS: PRACTICAL INDICATORS OF ENVIRONMENTAL QUALITY OF SIGNIFICANCE TO FISHERIES,
National Marine Fisheries Service, Milford, CT. Milford Lab.
A. C. Longwell.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 999-1005, October 1988. 3 fig, 37 ref.

Descriptors: *Fish eggs, *Embryonic growth stage, *Bioindicators, *Water pollution effects, Fish physiology, Sublethal effects, Monitoring, Mortality, Marine fisheries.

Cyto-embryological analyses of fish eggs collected in nature can be a more sensitive indicator of environmental pollution than more typical assays conducted on artificially-spawned eggs. This is because uncertainties associated with artificial spawning and rearing are dispensed with, as well as because of the sensitivity of some cellular and subcellular analyses. At the same time, such measures can provide information on interannual differences in egg viability of importance in elucidating great, unexplained variability in fisheries recruitment. Extensive experience with fish embryos from ocean plankton has led to the choice of a particularly useful, practical suite of observations for different developmental stages. This includes measures of embryo mortality, mutagenicity, teratogenicity, abnormal cell differentiation, and development rate. Atlantic mackerel egg mortality has been determined to be greater in the surface waters of the New York Bight apex and along the New Jersey coast than in less polluted portions of the Bight. Chromosome abnormality of mid-stage embryos was also greater in more impacted areas of the same water mass, as well as in the somatic cells of adult mackerel and winter flounder, and in juvenile and adult windowpane flounder caught in more impacted areas. Mortality and abnormality of the mackerel embryos showed statistical associations with toxic hydrocarbons as measured in plankton, and with heavy metals as measured in sea surface waters. The sensitivity, practicality, and relevance of the cytoembryological studies to population dynamics of resource species make this an important means of monitoring environmental quality. (Author's abstract)
W89-06055

SINGLE-COLUMN ION CHROMATOGRAPHY: IV. DETERMINATION OF ARSENATE IN SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
H. C. Mehra, and W. T. Frankenberger.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1603-1606, November-December 1988. 3 fig, 3 tab, 18 ref.

Descriptors: *Chromatography, *Metal complexes, *Arsenic compounds, *Pollutants identification, *Aquatic environment, Single column ion chromatography, Chloride, Nitrate, Phosphate, Sulfate, Atomic absorption spectrometry.

A method has been developed for the determination of arsenate in aqueous soil extracts by single column ion chromatography at trace levels. The eluent stream consisted of 6 mM p-hydroxybenzoic acid (PHBA) at pH 7.0. Separation was carried out on a low capacity anion exchange resin column with the anion species being quantified by conductometric detection. Resolution between arsenate and PO4(3-) was Rs = 1.93. The method allows precise trace amount measurement of arsenate (detection limit, 0.092 mg/L) in the presence of Cl, NO3(-), PO4(3-), and SO4(2-). The arsenate signal becomes masked limiting separation and detection when PO4(3-) exceeds 30 mg/L. Arsenite was not detected. Analysis of aqueous soil extracts for arsenate by single column ion chromatography agrees closely with those values obtained by atomic absorption spectrometry and inductively coupled plasma emission. (Author's abstract)
W89-06081

DEVELOPMENT OF THE FLAVOR PROFILE ANALYSIS METHOD INTO A STANDARD METHOD FOR SENSORY ANALYSIS OF WATER,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
I. H. Suffet, B. M. Brady, J. H. M. Bartels, G. Burlingame, and J. Mallevialle.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 1-9, 1988. 3 fig, 18 ref.

Descriptors: *Taste, *Water analysis, *Standards, *Odors, *Drinking water, *Organoleptic properties, Temperature, Laboratory equipment, Classification, Sampling, Reagents, Water quality, Flavor profile analysis.

The standard methods committee for the 1990 edition of Standard Methods for the Analysis of Water and Wastewater has decided to consider adding a new (provisional) method for the sensory analysis of drinking water, flavor profile analysis (FPA). A series of issues must be addressed before FPA can become a standard method. The methodology (e.g., temperature of aroma samples, sniffing technique, use of cups vs. flasks, rest intervals between samples, maximum number of samples examined per session) must be standardized. Reference standards for odors must be developed and implemented in order to achieve consistent odor quality descriptions. Methods for the statistical treatment of the data should be developed and standardized. The major issue for this item is the determination of the type of data the intensity ratings represent (nominal, ordinal, interval, or ratio). Reproducibility (quantitative and qualitative) has been examined, but the results are limited. This issue must be examined in more detail. A standardized vocabulary for the qualitative description of tastes and odors is needed. Ideally, these standard descriptions should be accompanied by a chemical which is known to have the quality in question. Some work has been performed in this area, but more work is needed. The development of standard descriptions and standard reference compounds should be concurrent with the development of a classification scheme and flavor/odor wheel. The IAWPRC Specialist Group on Tastes and Odors is developing a classification scheme for natural waters. The authors are also developing a classification scheme for drinking water. These schemes should be compatible. (Doria-PTT)
W89-06101

RELATIONSHIP BETWEEN CONCENTRATION AND SENSORY PROPERTIES OF 2-METHYLISOBORNEOL AND GEOSMIN IN DRINKING WATER,
Osaka Prefecture Water Works Bureau (Japan). Water Testing Station.
T. Ito, T. Okumura, and M. Yamamoto.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 11-17, 1988. 5 fig, 4 tab, 12 ref.

Descriptors: *Odors, *Taste, *Organic compounds, *Drinking water, Organoleptic properties, Water temperature, Chlorine, Residual chlorine, Water quality.

The study of the relations between the senses of smell and taste and odorant concentration is important for the solution of odor problems. The threshold concentrations of odor and taste (TOC, TTC) of 2-methylisoborneol (MIB) and geosmin were measured by the non-forced choice triangle method using 12-20 panelists. Both TOC and TTC were found to be functions of water temperature and the concentration of residual chlorine. The TOC and TTC of mixed samples were rather lower than the concentrations calculated from the mixing ratio. The sensitivities of the consumer panel and the number of musty odor complaints from consumers are related to MIB or geosmin concentration. The ratio of the number of complaints to MIB (or geosmin) concentration decreased after maximum complaint, but the sensitivity of the consumer panel remained the same. (Author's abstract)
W89-06102

THRESHOLD DETECTION VALUES OF POTENTIAL FISH TAINTING SUBSTANCES FROM OIL SANDS WASTEWATERS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
C. G. Jardine, and S. E. Hrudey.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 19-25, 1988. 2 fig, 1 tab, 25 ref.

Descriptors: *Water pollution sources, *Detection limits, *Taste, *Oil wastes, *Fish, *Organoleptic properties, Wastewater, Organic compounds, Fisheries, Odors, Alberta, Biological magnification, Aromatic compounds, Water quality, Water pollution effects, Pollution.

Chemical compounds associated with oil sands extraction and upgrading operations have been implicated in the tainting of the Athabasca River fishery (Alberta), a commercial and subsistence fishery for local natives. Selected contaminants found in oil sands wastewaters, and judged to be candidate tainting compounds, were spiked in walleye flesh and subjected to screening odor and taste detection by a trained sensory panel. Twelve compounds were screened and eight were pursued for determination of detection thresholds based upon three separate sessions with a minimum of nine panelists. Taint detection threshold values ranging from 0.09 mg/kg for benzothiophene to 12.2 mg/kg for 2,6-dimethylnaphthalene were established. Of the compounds tested, naphthalene, benzothiophene, and 2,5-dimethylphenol have the lowest detection thresholds, and thus have the strongest capability of the compounds tested for causing taint in fish. Detection threshold values appear to be related to the molecular weight and vapor pressure of the compound. Although very few threshold detection values for specific tainting compounds in fish flesh are reported in the literature, such information is necessary to judge the significance of analytically determined concentrations of contaminants in fish tissue. However, determining whether any particular compound will cause tainting of fish will require consideration of its concentration in water and the bioconcentration factor for the compound with the fish species of concern. (Doria-PTT)
W89-06103

FLAVOR-PROFILE ANALYSIS: AN OBJECTIVE SENSORY TECHNIQUE FOR THE IDENTIFICATION AND TREATMENT OF OFF-FLAVORS IN DRINKING WATER,
Southern California Metropolitan Water District, La Verne. Water Quality Lab.
S. W. Krasner.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 31-36, 1988. 1 fig, 3 tab, 12 ref.

Descriptors: *Flavor-profile analysis, *Taste, *Pollutant identification, *Drinking water, *Odor control, *Odors, *Organoleptic properties, Organic compounds, Chlorine, Sulfur compounds, Reservoirs.

Flavor-profile analysis (FPA) is a sensory method utilizing a trained panel of four to six individuals. Reference materials are used to establish a common vocabulary for different odors found in drinking water. Known quantities of different taste-causing and odor-causing chemicals are evaluated to calibrate the panel on a consistent intensity scale. Each identifiable descriptor is assigned its own intensity. This method has been successfully applied in the analysis of musty-smelling compounds, e.g., 2-methylisoborneol (MIB). MIB samples and standards from 1 to 80 ng/L have been shown to observe the Weber-Fechner law (i.e., a plot of flavor intensity versus logarithm of concentration of MIB yielded a straight line). FPA has also been used to handle fishy/swampy odor prob-

lems. In many instances, specific causative organic compounds were not identified; however, FPA evaluations of water using different free-chlorine dosages and contact times made possible immediate resolution of these odor problems. FPA has yielded reproducible sensory data that have been useful in better understanding and handling off-flavors in drinking water. (Author's abstract)
W89-06105

DETECTION OF TASTE AND ODOR IN OSAKA'S DRINKING WATER,
Osaka Prefecture Water Works Bureau (Japan). Dept. of Engineering.
H. Sano.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 37-42, 1988. 4 fig, 3 tab, 7 ref.

Descriptors: *Taste, *Odors, *Detection limits, *Drinking water, *Osaka, Organoleptic properties.

Laboratory and consumer panels were used to determine the threshold odor concentration (TOC) of 2-methylisoborneol (MIB) and geosmin in municipal drinking water in Osaka. The consumer panel was also used to assess the taste of tap water. The results showed that laboratory panel TOCs of MIB and geosmin were 4 and 94 ng/L, respectively, while those of consumer panels were 12 and 360 ng/L, respectively. In taste assessment, 8% of consumers assessed drinking water as offensive or bad even when the tap water wasn't contaminated by musty odor substances. However, if it was contaminated by MIB at its TOC level, 17% of consumers assessed the water as offensive and bad. (Author's abstract)
W89-06106

STRUCTURE AND SENSORY ANALYSES OF TAINTING SUBSTANCES IN FINNISH FRESHWATER ENVIRONMENTS,
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
A. Veijanen, J. Paasivirta, and M. Lahtipera.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 43-48, 1988. 2 fig, 2 tab, 16 ref.

Descriptors: *Pollutant identification, *Finland, *Taste, *Fish, *Drinking water, *Water pollution effects, Organoleptic properties, Algae, Growth, Organic chemicals, Reservoirs, Degradation, Lipids, Rivers, Water quality, Pollutant identification, Aquatic environment, Molecular structure.

GC/MS/SNIFF/TASTE methods were used in Finland to identify the causes of three tainting problems in water and one in fish nets. Structure determination was often verified by comparison with authentic compounds. Algal growth was implicated as the source of geosmin and MIB in river water in Northern Finland and was associated with the appearance of tainting problems in raw water and reservoir water in Aland county. Terpenoids (e.g., camphor), degradation products of natural lipids (e.g., aldehydes, ketones, and unsaturated aliphatic compounds), and volatile organohalogen compounds were frequently found in contaminated water but showed minor tainting effects compared to geosmin and MIB. Di-tert.-butyl-p-cresol and chlorobenzene also produced only minor tainting effects. (Author's abstract)
W89-06107

WATER BLOOMS OF UROGLENA AMERICANA AND THE IDENTIFICATION OF ODOROUS COMPOUNDS,
Kobe City Water Works Bureau (Japan). Water Quality Lab.
H. Yano, M. Nakahara, and H. Ito.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 75-80, 1988. 5 fig, 13 ref.

Descriptors: *Chrysophyta, *Algae, *Eutrophication, *Odors, *Pollutant identification, Organoleptic properties, Water quality, Weather, Wind, Plankton, Chromatography, Gas chromatography, Mass spectrometry, Nuclear magnetic resonance, Organic compounds, Reservoirs, Japan.

Since July 1980, a strong fishy odor in the Nunobiki Reservoir (Japan) has been associated with water blooms of the alga Uroglena americana (Chrysophyceae). According to ecological studies, water blooms were formed hourly by vertical and horizontal accumulation. The movement of organisms was affected by weather conditions, including the amount of sunlight and the direction and velocity of the wind. To identify the odorous compounds, samples of this species were collected from water blooms by a plankton net. The odorous compounds were analyzed by gas chromatography mass spectrometry (GC-MS), nuclear magnetic resonance (NMR), and ultra-violet (UV) spectrometry. As a result, two odorous compounds, (E,E)-2,4-heptadienal and (E,Z)-2,4-heptadienal, were detected and identified. (Author's abstract)
W89-06111

EFFICIENCY AND RELEVANCE OF DIFFERENT CONCENTRATION METHODS FOR THE ANALYSIS OF OFF-FLAVOURS IN WATER,
Linkoeping Univ. (Sweden). Dept. of Water in Environment and Society.
B. V. Lundgren, H. Boren, A. Grimvall, R. Savenhed, and B. Wigilius.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 81-89, 1988. 3 fig, 1 tab, 13 ref.

Descriptors: *Pollutant identification, *Water analysis, *Taste, *Sample preparation, *Organoleptic properties, Water quality, Adsorption, Sampling, Chromatography, Gas chromatography, Solvents.

The efficiency of four different concentration methods (stripping with and without addition of salt, XAD-2 adsorption, and dichloromethane extraction) for the enrichment of off-flavor compounds in treated and untreated surface water has been evaluated by gas chromatographic sniffing and by sensory analysis of the concentrated extracts. In general, the extracts obtained by dichloromethane extraction and XAD-2 adsorption contained a larger number of off-flavor compounds than the stripping extracts. Experiments in which the extracts from stripping and dichloromethane extraction were dissolved in odorless water showed that the original odor quality of the water could normally be re-created from extracts obtained by solvent extraction but not from corresponding stripping extracts, proving that the choice of concentration method can be important. Fractionation of extracts by preparative gas chromatography followed by dissolving of the resulting fractions in odorless water was found to be a powerful technique for isolating the organic compounds causing the off-flavor of a water sample. (Author's abstract)
W89-06112

SIMPLE EXTRACTION PROCEDURE FOR MODERATELY VOLATILE TASTE AND ODOR COMPOUNDS SUCH AS GEOSMIN AND 2-METHYLISOBORNEOL: METHOD AND APPLICATIONS,
National Water Research Inst., Burlington (Ontario).
B. G. Brownlee, L. Gammie, W. D. Gummer, and G. A. MacInnis.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 91-97, 1988. 3 tab, 17 ref.

Descriptors: *Sample preparation, *Taste, *Odors, *Organic compounds, *Water analysis, *Organoleptic properties, *Water treatment, Sampling, Pollutant identification, Chromatography, Gas chromatography, Solvents, Detection limits, Filtration, Monitoring, Activated carbon, Algae, Chlorination.

An extraction procedure is described which is the basis for a convenient method for analysis of large numbers of water samples for 2-methylisoborneol (MIB) and geosmin. The samples are extracted in a 2 L volumetric flask by stirring with two small volumes of hexane or pentane. An internal standard is added to the dried extracts which are concentrated and analyzed by capillary gas chromatography using a flame ionization detector. Hexane gives better recoveries than pentane, and moderate to high stirring speeds are required. At 250 ng/L, hexane extraction is 49% + or - 8% efficient for MIB and 59% for geosmin at moderate stirring speeds. The detection limit is about 20 ng/L. This method has been used to analyze for MIB and geosmin in several Canadian water supplies and has been in use since 1984 at the Buffalo Pound Water Treatment Plant to monitor geosmin for various studies: a preliminary survey prior to start-up of granular activated carbon (GAC) filtration for taste and odor control, monitoring performance of the GAC filters, and measuring release of geosmin from algae during pre-chlorination. (Author's abstract)
W89-06113

OFF-FLAVOR IN THE CHANNEL CATFISH (ICTALURUS PUNCTATUS) DUE TO 2-METHYLISOBORNEOL AND ITS DEHYDRATION PRODUCTS,
Mississippi State Univ., Mississippi State. Coll. of Veterinary Medicine.
J. F. Martin, L. W. Bennett, and W. H. Graham.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 99-105, 1988. 1 fig, 3 tab, 23 ref.

Descriptors: *Pollutant identification, *Taste, *Catfish, *Organic compounds, *Fish management, *Water pollution sources, *Water pollution effects, Organoleptic properties, Fish, Ponds, Fisheries, Metabolism, Fate of pollutants, Bioaccumulation, Tissue analysis, Liver, Muscle.

Off-flavor in channel catfish is a serious problem in the commercial culture industry affecting 50-80% of growout ponds during the warmer months of the year. A microwave distillation technique has been developed to isolate volatile compounds from affected material. 2-Methylisoborneol (MIB) is the predominant compound isolated from off-flavored catfish during the growing season (April-October) in west Mississippi and is responsible for a musty type of flavor. Geosmin and other as yet unidentified compounds are also important causes of an earthy type of off-flavor. 2-Methylenebornane and 2-methyl-2-bornene, dehydration products of MIB, were shown to contribute to the off-flavor problem. Chemical etiologies for other types of off-flavor (woody, rancid, sewage, stale) have not been identified. The absorption (2 hours) and depuration (48 hours) of MIB in catfish fingerlings were determined. MIB and its dehydration products are concentrated primarily in subepidermal and abdominal fat. Lesser concentration occurs in the liver and muscle tissue of off-flavored fish. Removing fish to clean, flowing water to purge MIB and geosmin could provide a partial means for off-flavor abatement. (Author's abstract)
W89-06114

IDENTIFICATION OF VOLATILE METABOLITES PRODUCED BY BLUE-GREEN ALGAE,
Tokyo Metropolitan Research Lab. of Public Health (Japan).
Y. Tsuchiya, and A. Matsumoto.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 149-155, 1988. 2 fig, 1 tab, 16 ref.

Descriptors: *Odor-producing algae, *Pollutant identification, *Taste, *Odors, *Cyanophyta, Organoleptic properties, Algae, Metabolism, Oscillatoria, Anabaena, Aphanizomenon, Chromatography, Gas chromatography, Mass spectrometry, Alcohols, Hydrocarbons, Culture media, Japan.

A series of volatile metabolites has been identified, by means of gas chromatography/mass spectrometry, in extracts of the culture media of eight species of blue-green algae which produce earthy-musty odorous compounds and cause an unpleasant odor and taste in water supplies. 2-Methylisoborneol (MIB) was identified as a metabolite of Oscillatoria geminata, O. limnetica, Phormidium tenue, and Oscillatoria sp. Geosmin was detected in extracts of the culture media of O. splendida, Aphanizomenon flos-aquae, O. amoena, Anabaena macrospora, and Oscillatoria sp., and germacrene-D was found to be a metabolite of O. splendida, O. amoena, and A. macrospora. Sesquiterpene alcohols were detected in extracts of the culture media of O. splendida, O. amoena, A. macrospora, and Oscillatoria sp. These sesquiterpene compounds were detected only in blue-green algae which pro-

duced geosmin. The aliphatic hydrocarbons n-heptadecane, 1-heptadecene, and 7-methylheptadecane were detected in extracts of almost all of the blue-green algae studied. n-heptadecane was a major metabolite in the culture media of all of the blue-green algae studied. MIB and geosmin were the only compounds with unpleasant odors that were produced by the eight species of blue-green algae studied. (Doria-PTT)
W89-06120

AQUATIC OFF-FLAVOURS: PAST, PRESENT AND FUTURE,
Helsinki Univ. (Finland). Dept. of Limnology.
P. E. Persson.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 283-288, 1988. 41 ref.

Descriptors: *Taste, *Organoleptic properties, *Odor control, *Chemical analysis, *Biochemistry, *Water pollution sources, *Water treatment, Reviews, Symposium, Microbiological studies, Water quality, Fish, Physiological ecology, Technology.

Developments in the field of aquatic off-flavors are reviewed. Within the field of aquatic off-flavors, the past decade has seen many advances. The developments within the sensory and chemical analysis of aquatic odors have produced more reliable and sensitive methods. Odor standardization is progressing, and as a result powerful means to address new and unsolved flavor problems will be developed. Eventual applications of gene technology to the analysis of off-flavors may result in even more powerful tools. Important new information on the biosynthesis and biochemistry of flavor compounds is emerging, which will lead to an understanding of the mechanisms of odor production more completely. In the technology of odor abatement, the application of various biotechnologies holds much promise, and may lead to wide-scale applications in a few years. (Doria-PTT)
W89-06138

HEAVY METALS AND OTHER NON-OIL POLLUTANTS IN SOUTHEAST ASIA,
Chulalongkorn Univ., Bangkok (Thailand). Dept. of Marine Science.
M. Hungspreugs.
Ambio AMBOCX, Vol. 17, No. 3, p 178-182, 1988. 12 tab, 29 ref.

Descriptors: *International agreement, *Heavy metals, *Water pollution effects, *Southeast Asia, Water quality, Marine sediments, Water pollution sources, Chlorinated hydrocarbons, Philippines, Thailand, Singapore, Domestic wastes, Urban runoff, Indonesia, Malaysia, Nutrients, Management planning.

Cooperative work on heavy metals and other non-oil pollutants in Southeast Asia began systematically in 1981 on adoption of the UNEP East Asian Seas Action Plan. The five countries taking part in the action plan are Indonesia, Malaysia, the Philippines, Singapore, and Thailand. The parameters agreed upon at a 1983 Workshop included general water quality, nutrients, chlorinated hydrocarbons, and heavy metals in water, sediments and biota. So far, there has been no report on real problem areas in regard to chlorinated hydrocarbons or heavy metals. In most cases, pollution was caused by untreated domestic-waste runoff from cities. There is an obvious need to create a co-ordinated analytical capacity between national laboratories in the region. (Author's abstract)
W89-06169

DETERMINATION OF URANIUM IN NATURAL GROUNDWATERS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
A. Kerr, W. Kupferschmidt, and M. Attas.
Analytical Chemistry ANCHAM, Vol. 60, No. 24, p 2729-2733, December 15, 1988. 4 fig, 5 tab, 11 ref.

Descriptors: *Water analysis, *Uranium radioisotopes, *Radioactive waste disposal, *Pollutant identification, *High performance liquid chromatography, Automation, Leaching, Groundwater pollution, Water pollution sources.

A procedure using high-performance liquid chromatography (HPLC) and trace enrichment techniques has been developed to measure trace levels of uranium in solutions containing high concentrations of dissolved salts. This procedure is required to support research into the feasibility of deep geological disposal of used nuclear fuel, which includes studying the leaching of uranium from fuel by natural groundwaters. After conditioning, several milliliters of sample are passed through a small reversed-phase enrichment cartridge, where the uranium is concentrated and separated from the bulk of other constituents. The uranium is then back flushed from the column onto a reversed-phase analytical column where further separation is achieved. The separated species are monitored spectrophotometrically after postcolumn reaction with the chromogenic reagent Arsenazo III. Analysis of simulated groundwaters has shown the procedure to be free from major interferences. Automation of the system using automatic switching valves and an automated sample injector allows approximately 40 samples per day to be analyzed with a measurement precision of about 4%. Detection limits are in the 1-2 ng/ml range. (Author's abstract)
W89-06176

PHOTOMETRIC METHOD FOR THE DETERMINATION OF LOW CONCENTRATIONS OF HYDROGEN PEROXIDE BY THE PEROXIDASE CATALYZED OXIDATION OF N,N-DIETHYL-P- PHENYLENEDIAMINE (DPD),
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5F.
W89-06185

SOLID PHASE EXTRACTION OF ACROLEIN 2,4-DINITROPHENYLHYDRAZONE FOR HPLC ANALYSIS,
Community and Occupational Health, Edmonton (Alberta).
P. Oltmann, R. W. Coppock, L. E. Lillie, and J. W. Moore.
Water Research WATRAG, Vol. 22, No. 9, p 1143-1145, September 1988. 1 fig, 1 tab, 14 ref.

Descriptors: *Biocides, *Herbicides, *Acrolein, *High pressure liquid chromatography, *Pollutant identification, Separation techniques, Polarographic analysis.

Acrolein (propenal) is used as an aquatic biocide to control plant growth in irrigation canals. Due to the short lifetime and reactivity of acrolein, a simple, rapid, and accurate method for its determination in water is needed to study its toxicity to fish and aquatic birds. Solid phase extraction (SPE) was employed for the separation of the acrolein 2,4-dinitrophenylhydrazone from strong acids for HPLC analysis. Analysis speed, precision and simplicity were increased over conventional liquid-liquid extractions and samples could be stored on SPE columns for at least 2 weeks before HPLC analysis making the method especially appealing for field sample collection applications. The precision was + or - 3% over the range 0.1-16 micrograms/ml and the quantitation limit was 0.04 micrograms/ml, defined as four times the variance of the blank. (Geiger-PTT)
W89-06189

HEAVY METAL CONCENTRATIONS OF LYMNAEA STAGNALIS L. IN THE ENVIRONS OF LAKE BALATON (HUNGARY),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
K. V.-Balogh, D. Salabarria Fernandez, and J. Salanki.
Water Research WATRAG, Vol. 22, No. 10, p 1205-1210, October 1988. 5 fig, 3 tab, 26 ref.

Descriptors: *Snails, *Bioindicators, *Hungary, *Lake Balaton, *Heavy metals, *Gastropods, *Path of pollutants, Tissue analysis, Chromium, Cadmium, Mercury, Lead, Zinc, Copper, Manganese, Iron, Atomic absorption spectrophotometry.

The concentrations of eight heavy metals (Cr, Cd, Hg, Pb, Zn, Cu, Mn, and Fe) were determined for the total soft body of pond snails (Lymnaea stagnalis--Gastropoda, Pulmonata) originating from four different biotopes in the environs of Lake Balaton, using atomic absorption spectrophotometry. The concentration of toxic metals (Cr, Cd, Hg, and Pb) showed a linear decreasing tendency with increasing body weight. For the biogenic metal concentration, no decreasing correlation was detected with the body weight, but metal content (Zn, Cu, Mn, and Fe) increased significantly ($P < 0.001$-0.01) with the increase in body weight. Significant differences ($P < 0.001$-0.01) were found in the Cr, Hg, Pb, and Fe concentrations in animals originating in different biotopes. Heavy metal concentrations found in L. stagnalis apparently reflect differences in pollution of the environment. (Author's abstract)
W89-06215

CHARACTERIZATION OF POLYETHOXYLATED SURFACTANTS AND THEIR BROMINATED DERIVATIVES FORMED AT THE WATER TREATMENT PLANT OF BARCELONA BY GC/MS AND FAB MASS SPECTROMETRY,
Aigues de Barcelona (Spain).
F. Ventura, A. Figueras, J. Caixach, I. Espadaler, and J. Romero.
Water Research WATRAG, Vol. 22, No. 10, p 1211-1217, October 1988. 7 fig, 1 tab, 29 ref. CAICYT and CSIC Grant PR508.

Descriptors: *Pollutant identification, *Halogenated organic compounds, *Surfactants, *Water analysis, *Water treatment, *Mass spectroscopy, *Gas chromatography, Chlorination, Barcelona, Spain, Llobregat River, Comparison studies, Halogenation, Water treatment facilities, Organic compounds.

Polyethoxylated C12-C15 alcohols, nonylphenols, and ((nonylphenoxy) polyethoxy) acetic acid and their brominated derivatives were identified in the River Llobregat and the tap water of Barcelona by GC/MS and FAB mass spectrometry. Whereas GC/MS is limited to those compounds with a low polyethoxylation degree, FAB mass spectrometry is a fast and simple technique to determine surfactants with a high range of oligomers present in the samples. The techniques are regarded as complementary. The source of the compounds studied is the discharge of effluent wastes of surfactant industries and dyeing and textile processes. Their brominated derivatives are formed in the chlorination stages in the waterworks due to a high content of bromide ions in the upper course of the river. (Author's abstract)
W89-06216

VARIABILITY AMONG BLUEGILL VENTILATORY RATES FOR EFFLUENT TOXICITY BIOMONITORING,
Battelle Columbus Div., OH.
R. S. Hayward, N. G. Reichenbach, L. A. Dickson, and T. J. Wildoner.
Water Research WATRAG, Vol. 22, No. 10, p 1311-1315, October 1988. 2 fig, 1 tab, 17 ref.

Descriptors: *Biomonitoring, *Bluegills, *Toxicity, *Wastewater analysis, *Monitoring, *Bioassay, *Respiration, Fish, Ventilatory frequency, Performance evaluation, Continuous biomonitoring, Arkansas, Effluents, Daphnia, Variability.

The lack of standard analytical procedures for continuous biomonitoring (CB) is a major impediment to broadscale use of this concept. Measurements of toxicity (48-hr Daphnia magna acute toxicity tests) in wastewater effluent from the U.S. Army Pine Bluff Arsenal, Arkansas, were used to evaluate performance of a CB system that measures ventilatory frequencies (VFs) of bluegills, Lepomis macrochirus, also exposed to the same efflu-

ent. A synchronous, control-, treatment-group experimental design, focusing on within-group variability in the VF response among individual bluegills, detected acute toxicity in complex effluents, with a low rate of false alarms. Variability-based monitoring performed better than monitoring that compared mean and median VFs between control- and treatment-group fish. A simple, non-parametric statistical test (Ansari-Bradley procedure) was used to decide when differences in VF variability between control (tap water-receiving) and treatment (effluent-receiving) fish groups were significant. Desirable features associated with the synchronous, control-treatment design comparing variability in the VF responses, include a direct relationship between response magnitude and a broad range of toxicity levels in complex effluents, analytical simplicity, and an ability to screen potentially confounding 'outside' disturbances. (Author's abstract)
W89-06228

DOSING SYSTEM TO VARY PH, SALINITY, AND TEMPERATURE,
Maryland Univ., Baltimore. School of Medicine.
A. S. Kane, R. O. Bennett, and E. B. May.
Water Research WATRAG, Vol. 22, No. 10, p 1339-1344, October 1988. 7 fig, 5 ref.

Descriptors: *Water pollution effects, *Acid rain effects, *Culturing techniques, *Laboratory equipment, *Bioassay, *Hydrogen ion concentration, *Salinity, *Water temperature, Toxicity, Design criteria.

Construction of a dosing system to expose small aquatic organisms to varying pH and salinity under different temperature regimes is discussed. The design allows for three controlled pH levels and two salinity levels across three temperature regimes. The system is flexible and may be adapted for other experimental paradigms including pH depression, elevation, or maintenance as well as use with various dilution media or 'toxicants' other than salt. Schematic diagrams of system components are included. (Author's abstract)
W89-06232

ESTIMATION OF DESCRIPTIVE STATISTICS FOR MULTIPLY CENSORED WATER QUALITY DATA,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06256

NONPARAMETRIC STATISTICAL METHODS FOR COMPARING TWO SITES BASED ON DATA WITH MULTIPLE NONDETECT LIMITS,
CH2M/Hill, Bellevue, WA.
For primary bibliographic entry see Field 7C.
W89-06263

POTENTIOSTATIC METHOD FOR THE SENSITIVE MEASUREMENT OF THE CHEMICAL OXYGEN DEMAND (COD) (EIN POTENTIOSTATISCHES VERFAHREN ZUR EMPFINDLICHEN BESTIMMUNG DES CHEMISCHEN SAUERSTOFFBEDARFS (CSB)),
Entwicklungsgesellschaft fuer Umwelttechnik m.b.H., Berlin (Germany, F.R.). Laser and Analytical Research.
U. Pilz, and M . Werner.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 203-207, October 1988. 7 fig, 1 tab, 10 ref. English summary.

Descriptors: *Water quality, *Chemical oxygen demand, *Electrochemistry, *Measuring instruments, Oxidation, Oxygen, Ozone, Organic compounds, Molecular structure, Electrolysis, Electrodes, Potentiometric level, Reproducibility.

Chemical oxygen demand (COD) is important in the determination of water quality. A method of measuring oxidizable substances using a potentiostatic device is presented. In the electrolysis of water short-lived reactive oxygen compounds, such as hydroxyl radicals, monatomic oxygen, ozone, and molecular oxygen, are formed on the anode. The principle of operation of the measuring device is based on the fact that the dissolved substances in a water sample become oxidized by the reactive oxygen species formed on the anode. The current which consequently streams through the aqueous solution is measured and is, according to Faraday's law, a measure at any given time of the quantity of test substance transported to the electrodes. Tests were conducted to determine whether substances of different molecular structure and weight were differently oxidized. Compounds investigated included sugars, amino acids, aromatic compounds, acetone, urea, thiourea, and hexamethylenetetramine. For comparison of individual results the current-density differences for each concentration of the employed substances for eight different potentials were determined and the respective COD is presented. The results point out the efficiency of this method and show the reproducibility of the measurement results. (Shidler-PTT)
W89-06287

OCCURRENCE AND BEHAVIOUR OF LINEAR ALKYLBENZENESULPHONATES, NONYLPHENOL, NONYLPHENOL MONO- AND NONYLPHENOL DIETHOXYLATES IN SEWAGE AND SEWAGE SLUDGE TREATMENT,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
For primary bibliographic entry see Field 5D.
W89-06292

COMPARISON OF CYTOPATHOGENICITY, IMMUNOFLUORESCENCE IN IN SITU DNA HYBRIDIZATION AS METHODS FOR THE DETECTION OF ADENOVIRUSES,
Health Effects Research Lab., Cincinnati, OH.
C. J. Hurst, K. A. McClellan, and W. H. Benton.
Water Research WATRAG, Vol. 22, No. 12, p 1547-1552, December 1988. 3 tab, 21 ref.

Descriptors: *Pathogens, *Fluorescence, *Pollutant identification, *Viruses, *Culturing techniques, *DNA hybridization, *Adenoviruses, Microscopic analysis, Detection times, In situ tests, Enteroviruses, Raw wastewater, Cytopathogenicity, Immunofluorescence.

Three different methods were compared for their efficiency at detection of adenoviruses. The samples examined for viral analysis consisted of concentrates prepared from raw sewage, chosen as providing a representation of the spectrum of viruses being intestinally shed from a large population at any given time. When using one single cell line, HEp-2, the overall numbers of adenoviruses detected using cytopathogenicity and immunofluorescence were roughly equal. In situ hybridization was approximately 40% more sensitive than either of these other methods as determined by average virus titers for the different samples, and also proved to be better by means of a nonparametric comparison. The 293 cell line was approximately 5 times more sensitive for detecting adenoviruses by cytopathogenicity as compared with the HEp-2 cell line, but proved unsuitable in our hands for quantitatively detecting indigenous adenoviruses by immunofluorescence. The relative number of indigenous adenoviruses present in the sewage concentrates we examined was, on average, 94-fold greater than that of enteroviruses. Assay of enteroviruses was performed by plaque assay in the BGM cell line. (Author's abstract)
W89-06302

CAMPYLOBACTERS IN MAN AND THE ENVIRONMENT IN HULL AND EAST YORKSHIRE,
Public Health Lab. Service, Hull (England). Hull Royal Infirmary.
S. L. Mawer.
Epidemiology and Infection, Vol. 101, No. 2, p 287-294, October 1988. 1 fig, 1 tab, 14 ref.

Descriptors: *Pathogenic bacteria, *Bacteria, *Bacterial analysis, *Campylobacter, Human diseases, Ponds, Drains, Path of pollutants.

Campylobacter organisms isolated from water samples taken weekly from ponds and land-drains in the City of Hull were compared with isolates from humans. Of 314 campylobacter organisms isolated from patients, 237 (75.5%) of the strains were identified as typical Campylobacter jejuni, while of 125 identified strains isolated from the water samples, 85 (68%) resembled C. jejuni in most respects, but were hippurate hydrolysis negative. The ponds and land drains in the city were therefore not a source of campylobacteriosis in the people living near these water courses. The atypical C. jejuni strains isolated from the environment may be mistaken for the C. jejuni strains which cause human infection. It is therefore essential that such strains are fully identified before attributing human and animal infections to their ingestion. (See also W89-06311) (Author's abstract)
W89-06310

PATHOGENICITY OF ENVIRONMENTAL CAMPYLOBACTERS--A HUMAN VOLUNTEER EXPERIMENT,
Public Health Lab. Service, Hull (England). Hull Royal Infirmary.
For primary bibliographic entry see Field 5C.
W89-06311

WATER QUALITY CONTROL TRIALS: STATISTICAL TABLES FOR DIRECT COMPARISON BETWEEN MEMBRANE FILTRATION BACTERIAL COUNTS AND THE MULTIPLE TUBE METHOD WITH A DESCRIPTION OF THE BACTERIOLOGICAL METHOD,
Central Public Health Lab., London (England). Communicable Disease Surveillance Centre.
H. E. Tillett, A. E. Wright, and S. Eaton.
Epidemiology and Infection, Vol. 101, No. 2, p 361-366, October 1988. 1 fig, 2 tab, 4 ref, append.

Descriptors: *Sampling, *Bacterial counting, *Membrane filters, *Data interpretation, *Coliforms, *Water quality, *Statistical methods, *Bacterial analysis, Water sampling, Water quality control, England.

Experiments in the quality control of water samples are being conducted in 53 Public Health Laboratories and 39 Water Authority laboratories in the United Kingdom. Two methods are used for preparing and distributing samples; some participating laboratories use the multiple tube method and some use membrane filtration to assess the presence of coliforms and Escherichia coli. The results are, therefore, a mixture of estimated numbers and direct colony counts. In order to compare results from these two different laboratory methods statistical tables have been compiled to show the most likely multiple tube result corresponding to each colony count. Tables relating to two commonly used tenfold dilution series are presented to form a typical quality control distribution. The analyses of these results form a typical quality control distribution. The analyses of these results are generally satisfactory but show a tendency for lower counts using the membrane filtration method and more false negative results with E. coli counts. (Author's abstract)
W89-06312

FREON FC-113, AN ALTERNATIVE TO METHYLENE CHLORIDE FOR LIQUID-LIQUID EXTRACTION OF TRACE ORGANICS FROM CHLORINATED DRINKING WATER,
Drexel Univ., Philadelphia, PA. Dept. of Chemistry.
E. A. Ibrahim, and I. H. Suffet.
Journal of Chromatography JOCRAM, Vol. 454, p 217-232, November 1988. 7 fig, 7 tab, 21 ref.

Descriptors: *Pollutant identification, *Drinking water, *Water analysis, *Sample preparation, Methylene chloride, Organic compounds, Freon, Liquid-liquid extraction, Aromatic hydrocarbons,

Hydrocarbons, Chlorinated hydrocarbons, Phenols, Ketones.

Freon FC-113 was compared with the standard solvent for liquid-liquid extraction of base-neutral organic compounds from water. The results showed that the extraction efficiency of both solvents were comparable when 100-300 ng/liter of nonpolar organics are extracted and concentrated 1000-fold. Solvent blanks showed that Freon had no contaminants at 200-fold concentration, and when used to extract chlorinated water, no by-products were observed. Field sampling and quality assurance considerations indicated that Freon is an acceptable substitute to methylene chloride for the isolation of trace organic compounds when large volumes of chlorinated waters are concentrated 100,000-fold for toxicity testing or gas chromatography and gas chromatography-mass spectrometry. Use of Freon avoids the problem of the cyclohexene preservative in methylene chloride. This compound reacts with residual free chlorine to form a variety of chlorinated and oxidized cyclohexene products, which produce artifacts and interfere with Ames tests. Freon also evaporates more quickly than methylene chloride. (Cassar-PTT)
W89-06367

RECOVERY OF ORGANIC COMPOUNDS FROM LARGE-VOLUME AQUEOUS SAMPLES USING ON-LINE LIQUID CHROMATOGRAPHIC PRECONCENTRATION TECHNIQUES,
Ecole Superieure de Physique et de Chimie Industrielles, Paris (France). Lab. de Chimie Analytique.
P. Subra, M. C. Hennion, and R. Rosset.
Journal of Chromatography JOCRAM, Vol. 456, No. 1, p 121-141, December 2, 1988. 9 fig, 6 tab, 27 ref.

Descriptors: *Pollutant identification, *Water analysis, *Sample preparation, *Organic compounds, *Chromatography, Phenols, Hydrocarbons, Herbicides, Phthalates.

In order to achieve maximal solute preconcentration on one or two given precolumns, it is necessary to use a sample volume larger than the breakthrough volume, even at the risk of obtaining recoveries lower than 100%. This is important when water samples contain only traces of the organic pollutants to be determined. A theoretical model is proposed for these conditions, using a single precolumn or two precolumns in series. Several experimental methods for measuring amounts of preconcentrated solutes and the corresponding recoveries are compared. A recommended procedure for the measurement of recoveries is proposed, involving the determination of variations of peak areas obtained during the determination of preconcentrated compounds in increasing volumes of water samples. In each sample, the concentration of the solutes is adjusted to a constant amount. This method has the advantage that recoveries are measured under the same chromatographic conditions as those used for the real sample. At the same time breakthrough volumes can be estimated. Several solutes can be studied simultaneously, and the efficiency of spiking can also be tested by this approach. A range of organic pollutants of medium to low polarity and two adsorbents (a bonded C18 silica and the polymer-based FRP-1) were chosen as a model system. (Author's abstract)
W89-06368

SELECTIVE ENRICHMENT PROCEDURES FOR THE DETERMINATION OF POLYCHLORINATED BIPHENYLS AND POLYCYCLIC AROMATIC HYDROCARBONS IN ENVIRONMENTAL SAMPLES BY GEL PERMEATION CHROMATOGRAPHY,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
P. Fernandez, C. Porte, D. Barcelo, J. M. Bayona, and J. Albaiges.
Journal of Chromatography JOCRAM, Vol. 456, No. 1, p 155-164, December 2, 1988. 3 fig, 3 tab, 15 ref.

Descriptors: *Pollutant identification, *Water analysis, *Sample preparation, *Chromatography, *Organic compounds, *Aromatic hydrocarbons, Hydrocarbons, Polychlorinated biphenyls, Gel permeation chromatography, Polycyclic aromatic hydrocarbons, Sediments, Aquatic life.

Two packing materials for gel permeation chromatography were tested for selective trace enrichment of polychlorinated biphenyls (PCBs) and polyaromatic hydrocarbons (PAHs). These were Bio-Beads SX-3 (for seven PCB cogeners in biota) and Bio-Beads SX-12 (for PAHs and sulfur-containing compounds from particulates and river sediments). A reference material (NBS SRM 1648) was used in the PAH experiments as a standard. Recoveries varied from 52 to 78%, depending on the compound. An advantage of this cleanup method is preservation of the more polar PAHs during processing. (Cassar-PTT)
W89-06369

MODIFIED MPN METHOD FOR COUNTING OLIGOTROPHIC BACTERIA BY USING NATURALLY OCCURRING ORGANICS,
Kyoto Univ. (Japan). Dept. of Fisheries.
For primary bibliographic entry see Field 2H.
W89-06371

ANTIBIOTIC RESISTANT COLIFORM AND FAECAL COLIFORM BACTERIA IN DRINKING WATER,
Biological Research Center, Baghdad (Iraq). Dept. of Environmental Pollution.
For primary bibliographic entry see Field 5F.
W89-06394

GAS CHROMATOGRAPHIC DETERMINATION OF VOLATILE SULFIDES AT TRACE LEVELS IN NATURAL FRESHWATERS,
McMaster Univ., Hamilton (Ontario). Dept. of Geology.
F. Caron, and J. R. Kramer.
Analytical Chemistry ANCHAM, Vol. 61, No. 2, p 114-118, January 15, 1989. 3 tab, 3 fig, 29 ref.

Descriptors: *Pollutant identification, *Sulfides, *Detection limits, *Gas Chromatography, *Water analysis, Sulfur, Trace levels, Chemical analysis, Hall electrolytic conductivity detector.

A simple and reliable method of analysis for volatile sulfides was developed for fresh water samples by degassing the solution and cryogenically trapping the volatiles. The Hall electrolytic conductivity detector was a key factor for achieving low detectability, multiple component calibration, and reproducibility of the calibration curves. The signal of the detector is linear with the amount of analyte, and the working range is greater than 3 orders of magnitude. Detection limits in the range of picograms of sulfur are generally better than those found in other studies. The precision is better than 10% for the range of 1-4000 ng of S/L. However, the column does not decisively separate H2S from COS at 40 C. Replicate analyses of water samples show changes in reduced sulfide concentrations during storage of only a few hours, probably due to microbial activity. An effective preservative agent for these compounds in water is needed. (White-Reimer-PTT)
W89-06407

BIOLOGICAL INDICATION OF TROPHY AND POLLUTION OF RUNNING WATERS,
Landesamt fuer Wasserwirtschaft, Munich (Germany, F.R.). Dept. of Limnology.
C. Steinberg, and S. Schiefele.
Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 227-234, December 1988. 2 tab, 13 fig, 36 ref.

Descriptors: *Eutrophication, *Bioindicators, *Trophic level, *Diatoms, *Pollution index, Benthic flora, Running waters, Rivers, Streams, Amper River, Bavaria, Germany, Indicators, Phosphorus, Nutrients.

The universally distributed benthic diatoms of streams and rivers are used as trophic bioindicators. Existing methods have been improved on by: (1) dividing the pollution differentiating diatom species into five groups instead of three, and (2) introducing two new groups of nutrient differentiating diatoms, oligophent and eutraphent species. Based on the relative frequencies of these seven groups a scheme is proposed which classifies from unpolluted, nutrient poor sites to heavily polluted sites. The application of this method was demonstrated with studies of the Amper River in which seven river sites and five tributaries were sampled. In several instances, the diatom classification reflects changes in nutrient concentrations fairly well, especially at low phosphorus levels, but it is assumed that diatom communities are indicators of different production levels rather than poor nutrient concentrations. As lake flow biocenoses develop downstream of every barrage, the trophic classification system appears to be a better system than the saprobic one. (White-Reimer-PTT)
W89-06416

BIOLOGICAL TESTS FOR THE ASSESSMENT OF EUTROPHICATION IN RUNNING WATERS,
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
D. Muller.
Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 240-247, December 1988. 1 tab, 6 fig, 15 ref. English summary.

Descriptors: *Eutrophication, *Water pollution effects, *Bioindicators, *Algal growth, *Aquatic productivity, *Nutrients, Algae, Streams, Rivers, Running waters, Biomass.

Although for lakes and ponds there is an extensive theoretical knowledge of how algae react to changes in nutrient supply, research work on interrelations between nutrients and algae development in flowing waters is not as extensive. Since in flowing waters favorable conditions for algae usually exist for only a short period, the nutrient reserves are seldom transformed completely into algae biomass. This fact suggests that Liebig's law and the algae-growth potential tests introduced in limnology have a limited use in the assessment of eutrophication processes in streams. Of greater importance than the relationship between nutrient supply and maximum biomass that can be produced is usually the interrelation between nutrient supply and algae growth rate. In planning eutrophication tests this factor must be taken into consideration. (Author's abstract)
W89-06418

PHOTOTAXIS IN AQUATIC INVERTEBRATES: POSSIBLE USE IN ECOTOXICITY TESTS,
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
G. Dojmi Di Delupis, and V. Rotondo.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 189-193, December 1988. 1 fig, 6 ref.

Descriptors: *Animal behavior, *Aquatic animals, *Invertebrates, *Phototaxis, *Toxicity, *Bioindicators, Ecological effects, Juvenile growth stage, Daphnia, Crustaceans, Mosquitoes, Light intensity, Light quality, Water pollution effects.

A series of experiments has been carried out aimed at (1) a deeper study of the phototaxis of some aquatic invertebrates and (2) its possible use in ecotoxicity tests. For the first point, the phototaxis of the nauplii of Artemia salina was examined: through tests carried out under different conditions, it was observed that a marked complex response to light existed, which led to a subdivision between individuals with different phototactic response, mainly depending on the density of the nauplii, on light intensity, and on spectral composition. The second point has been analyzed with A. salina, Daphnia magna, and Aedes aegypti. For the first species, it must be stressed that in ecotoxicity tests carried out with nauplii of A. salina one should bear in mind the complexity of their phototactic response. With D. magna and A. aegypti, a simple pvc apparatus connected with optic fibers

and set up on a microscope was used. The result is marked and easily observable; therefore, it will be possible in the future to perform tests easily with toxic substances which are important in ecotoxicology. (Author's abstract)
W89-06520

USE OF ALGAL FLUORESCENCE FOR DETERMINATION OF PHYTOTOXICITY OF HEAVY METALS AND PESTICIDES AS ENVIRONMENTAL POLLUTANTS,
Quebec Univ., Trois-Rivieres. Centre de Recherche en Photobiophysique.
G. Samson, and R. Popovic.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 272-278, December 1988. 3 fig, 1 tab, 31 ref. NSERC Grants G-1929, G-1930, and A-3047.

Descriptors: *Algae, *Fluorescence, *Phytotoxicity, *Heavy metals, *Pesticides, *Water pollution effects, *Bioindicators, *Toxicity, Dunaliella, Chlorophyta, Estimating, Mercury, Copper, Herbicides, Monitoring, Insecticides.

The phytotoxicity of heavy metals and pesticides was studied by using the fluorescence induction from the alga Dunaliella tertiolecta. The complementary area calculated from the variable fluorescence induction was used as a direct parameter to estimate phototoxicity. The value of this parameter was affected when algae were treated with different concentrations of mercury and copper, the herbicides atrazine and DCMU, and the insecticides Dutox, and Soilgard. The toxic effect of these pollutants was estimated by monitoring the decrease in the complementary area, which reflects photosystem II photochemistry. Further, the advantage of using the complementary area as a parameter of phytotoxicity over using variable fluorescence yield was demonstrated. The complementary area of algal fluorescence can be used as a simple and sensitive parameter in the estimation of the phytotoxicity of polluted water. (Author's abstract)
W89-06526

METHOD FOR EVALUATING EFFECTS OF TOXIC CHEMICALS ON THE PRODUCTIVITY OF FRESHWATER ECOSYSTEMS,
Shell Research Ltd., Sittingbourne (England).
For primary bibliographic entry see Field 5C.
W89-06527

SPECIATION OF METHYLTIN AND BUTYLTIN COMPOUNDS IN EELGRASS (ZOSTERA MARINA L.) LEAF TISSUE FROM THE GREAT BAY ESTUARY (NH),
New Hampshire Univ., Durham. Dept. of Chemistry.
R. Francois, and J. H. Weber.
Marine Chemistry MRCHBD, Vol. 25, No. 3, p 279-289, November 1988. 1 fig, 3 tab, 23 ref. NSF Grant CES-8612972.

Descriptors: *Pesticides, *Pollutant identification, *Atomic absorption spectroscopy, *Aquatic plants, *Plant tissues, *Organic compounds, *Tin, *Chemical analysis, Leaves, Water pollution, Heavy metals, Tissue analysis, Atomic absorption spectroscopy, Bioindicators, Sample preparation, Estuaries.

An analytical procedure is given for extraction of methyltin and butyltin compounds from eelgrass leaf tissue and their determination by a sensitive hydride generation-atomic absorption method. A 6 M HCl solution effectively extracts methyltin, and monobutyltin and dibutyltin compounds, but tributyltin requires 2/1 (v/v) dichloromethane-methanol for efficient extraction. Hydride formation of all compounds by sodium borohydride in aqueous media is effective except for tributyltin which requires use of tetrabutylammonium borohydride in dichloromethane. Determinations of methyltin and butyltin compounds in eelgrass samples from the Great Bay Estuary (NH) demonstrate that, at the time of sampling (October 1987), tributyltin pollution was minimal in this well-mixed estuarine system. Results from a mesocosm polluted with dibutyltin suggest that determination of butyltin compounds in seagrass tissue could be a sensitive means of detecting their presence in the aquatic environment, and could be used to monitor butyltin in pollution. (Author's abstract)
W89-06546

METHOD TO DETERMINE WATER TOXICITY BY VARIATIONS IN THE GILL AREA OF FISH (METHODIKA OPREDELENIIA TOKSICHNOSTI VODNOI SREDY PO IZMENENIIAM ZHABERNOGO APPARATE RYB),
All-Union Research Inst. of Pond Fisheries, Rybnoe (USSR).
S. B. Andronnikov, E. V. Ivanov, T. M. Lukina, and I. S. Shesterin.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 3, p 92-95, 1987. 2 ref. English summary.

Descriptors: *Toxicity, *Water pollution effects, *Bioassay, *Fish physiology, Sublethal effects, Gills.

A procedure was developed to estimate the toxicity of the aquatic environment by measuring the width of an apical end in the respiratory folds of the branchial petals (RFBP) of fish. The normal width of the apical end of RFBP in carp is 8.6 - 12.9 micrometers. The influence of environmental factors is estimated by the amount of damaged RFBP expressed as a percent of the total amount of the RFBP studied. (Author's abstract)
W89-06561

DIATOMS AS INDICATORS OF WATER QUALITY IN THREE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 2L.
W89-06607

BLUEGREEN ALGAE AS INDICATORS OF EUTROPHICATION IN THREE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 2L.
W89-06608

ESTABLISHING A LEVEL OF CONFIDENCE FOR THE ANALYTICAL VALUES FOR THE TRACE METALS IN THE LOS ALAMOS DRINKING WATER SUPPLY AND DISTRIBUTION SYSTEM,
R. Robinson, and D. Knab.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000725. Price codes: A03 in paper copy, A01 in microfiche. Report No. LA-11091-MS, October 1987. 22p, 7 tab, 4 ref, 5 append.

Descriptors: *Statistical analysis, *Water treatment, *Quality assurance, *Quality control, *Water analysis, *Trace metals, *Drinking water, Water quality control, Los Alamos, Monitoring, Standard deviation, Natural waters, Performance evaluation, Water conveyance, Water distribution.

The recoveries of metals in control samples and EPA Performance Evaluation samples obtained did not adequately indicate the confidence in the analytical data for the Los Alamos Drinking Water Supply and Distribution System specimens. The average recovery for all seven metals in each of the sample types (natural waters, deionized water, control samples, and EPA Performance Evaluation samples) was about 98%. However, the one-sigma relative standard deviations of those recoveries averaged 24% and 29% for known amounts of metals added as spikes versus 14% and 11% for the EPA Performance Evaluation samples and control samples. That difference in standard deviation may be due to either analytical precision problems or matrix interferences. Although most of the trace metal concentrations observed in the Los Alamos Drinking Water Supply and Distribution System specimens were at least one order of magnitude below the maximum contaminant levels, the standard deviations obtained for the spike recoveries were much greater than desired. The need to establish the cause of those differences in the standard deviations and reduce their magnitude in order to improve the confidence in the analytical data supports expansion of the program to include all the drinking water sources and the secondary pollutant metals: copper, iron, manganese, and zinc. (Author's abstract)
W89-06648

RECENT ADVANCES IN THE DETECTION OF HUMAN VIRUSES IN DRINKING WATER,
Health Effects Research Lab., Cincinnati, OH.
C. J. Hurst, and R. E. Stetler.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-132246. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/344, November 1987. 26p, 2 fig, 5 tab, 16 ref.

Descriptors: *Humic diseases, *Pollutant identification, *Viruses, *Drinking water, Water quality control, Bacteriophage, Hydrogen ion concentration, Microbiological studies, Filtration, Enteroviruses.

Simultaneous adsorption of poliovirus type 1 and the bacterial viruses f2 and theta-X 1774 onto electropositive and electronegative membrane filters was studied at pH levels ranging from 3.5 to 8.5. Binding of viruses to the filters was generally better at pH 3.5 rather than at the higher levels. Recovery of adsorbed viruses from the filters was studied utilizing as eluants a beef extract solution, and imidazole-buffered solutions of NaCl, NaCl containing Tween 80, and EDTA containing Tween 80. Efficiency of viral recovery by the combined membrane filter adsorption-elution procedure ranged from 0 to 61%. In a comparison of cytopathogenicity, immunofluorescence and in-situ DNA hybridization for the detection of indigenous viruses present in concentrated environmental samples, it was demonstrated that the detection efficiencies of the first two techniques were similar and not statistically different from one another. The efficiency of viral detection by in-situ DNA hybridization averaged 40% greater than that achieved by the other two techniques, and this difference was statistically significant. (Author's abstract)
W89-06653

1982 DETROIT MICHIGAN AREA SEDIMENT SURVEY,
Environmental Protection Agency, Chicago, IL. Great Lakes National Program Office.
P. E. Pranckevicius.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-133780. Price codes: A06 in paper copy, A01 in microfiche. Report No. 87-11, July 1987. EPA 906/4-87-003. 98p, 60 fig, 18 tab, 24 ref, 4 append.

Descriptors: *Michigan, *Surveys, *Sediments, *Pollutant identification, Chemical analysis, Polychlorinated biphenyls, Pesticides, Volatile organic compounds, Water pollution sources, Hexachlorobenzene, Detroit.

Twenty-eight sediment grab samples from the western bank of the Detroit River and three of its tributaries were chemically analyzed. Sampling sites were chosen to find worst-case conditions. High levels of conventional pollutants and metals were found throughout most of the study area. Hydrophobic organic contaminants found in a wide range of concentrations included: polynuclear aromatic hydrocarbons, polychlorinated biphenyls, various pesticides, and volatile organic compounds. Contaminant distributions suggest recent inputs from local sources. Highest contaminant levels were found in the Rouge River, the northern Trenton Channel and Conners Creek in the Belle Isle Area. The City of Detroit Wastewater Treatment Plant, combined sewer overflows, local steel and chemical industry and oil refineries are implicated as likely sources. Several contaminants including volatile organics, PCBs and hexachlorobenzene, seem to have major

upstream sources, perhaps in Lake St. Clair or the St. Clair River. (Author's abstract)
W89-06654

DETERMINATION OF A CHLORINATED FURANONE (MX) IN TREATED WATER,
Health Effects Research Lab., Cincinnati, OH.
J. W. Munch, W. E. Coleman, P. A. Hodakievic, W. H. Kaylor, and J. R. Meier.
Available from National Technical Information Service, Springfield, VA 22161, as PB88-1321188. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/343, November 1987. 13p, 3 fig, 2 tab, 6 ref.

Descriptors: *Pollutant identification, *Chlorination, *Chlorinated furanone, *Drinking water, Monitoring, Humic acids, Water treatment, Chemical analysis, Gas chromatography, Mass spectrometry, Mutagens, Reproducibility.

Recently a potent mutagen, 3-chloro-4-(dichlormethyl)-5-hydroxy2(5H)-furanone (MX) has been identified in three chlorinated drinking waters in the United States. It has also been identified in two chlorinated drinking waters by investigators in Finland. MX appears to account for a significant proportion of the total mutagenicity of these samples, as measured in the Ames test using strain TA100 without metabolic activation. Investigations into the products of chlorination of humic acids, which occur naturally in drinking water, indicate that this is the probable source of MX in chlorinated waters. Drinking water samples have been analyzed for MX by first concentrating organics using XAD resins, isolating a strong acid fraction using extraction techniques, and fractionating the strong acids using high performance liquid chromatography (HPLC). HPLC fractions containing MX were analyzed by the Ames test and by capillary column GC/MS. Mutagenicity levels determined by the Ames assay were correlated with the amount of MX present as quantified by GC/MS. The data show the reproducibility of the method and the average recovery of MX from spiked drinking water concentrates. (Author's abstract)
W89-06669

CHEMICAL AND BIOLOGICAL CHARACTERIZATION OF MUNICIPAL SLUDGES, SEDIMENTS, DREDGE SPOILS, AND DRILLING MUDS,
For primary bibliographic entry see Field 5D.
W89-06705

SLUDGE AND RISK ASSESSMENT,
Environmental Protection Agency, Washington, DC. Office of Research and Development.
D. J. Ehreth, and P. R. Jutro.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 2-6.

Descriptors: *Sludge, *Chemical analysis, *Risks, *Sludge disposal, *Environmental Protection Agency, *Policy making, Decision making, Workshops, Standards, History, Stochastic process, Mathematical studies.

As a by-product of treatment systems, sludge represents an intentional concentration of inorganic and reduced organic materials that deliberately has been prevented from entering rivers, lakes, oceans, or other receiving media because past experience and scientific evidence show them to be pollutants of concern. Sludges can contain toxic, pathogenic, and other environmentally hazardous substances at concentrations far higher than found in either untreated waste or plant effluent. Drilling muds and dredged materials may range from being considered 'completely safe' to 'significantly toxic.' The history of risk assessment at EPA has been variable over the years since the mid-1970s. In 1984, a risk assessment/risk management framework began to prevail at EPA, and workshops were developed to acquaint nonscientists to become more familiar with the process. A state-of-the-art health risk assessment at EPA attempts to accomplish four steps: (1) hazard identification, (2) dose-response assessment, (3) exposure assessment, and (4) risk characterization. (See also W89-06705) (Rochester-PTT)
W89-06706

REGIONAL AND STATE NEEDS IN SAMPLING AND ANALYTICAL METHODOLOGY,
Georgia Univ., Athens.
J. A. Little, J. H. Finger, and R. W. Knight.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 18-24.

Descriptors: *Chemical analysis, *Biomonitoring, *Research priorities, *Pollutant identification, *Effluents, Resource Conservation and Recovery Act, Publications, Regional planning, Wastewater analysis, Sludge, Spoil banks, Soil analysis, Sediments.

Sampling and analytical methods for chemical and biological analyses of sediments, sludges, dredge spoils, and soil samples are available in a number of publications, the contents of which are discussed. There also are draft and interim EPA documents in wide use. Needs exist for new methods to deal with such areas as long-term monitoring of Superfund remedial actions sites and body-contact toxicity testing at hazardous waste sites. Greater needs exist for: (1) standardization to insure that data for a particular environmental monitoring program will be comparable throughout the country; (2) consolidation of methodology across media/EPA program lines, for example, for water quality and hazardous waste investigation; (3) guidance on sample preservation methods; (4) validation of existing methodology for organic compounds other than those on the priority pollutant list or the hazardous substance list (Resource Conservation and Recovery Act Appendix VIII); and (5) reducing lag time to update or develop new methodology to accompany changing or new environmental regulations. (See also W89-06705) (Author's abstract)
W89-06709

SEDIMENT REFERENCE MATERIALS AND THE CANADIAN MARINE ANALYTICAL CHEMISTRY STANDARDS PROGRAM,
National Research Council of Canada, Halifax (Nova Scotia). Atlantic Research Lab.
P. G. Sim, W. D. Jamieson, S. S. Berman, and V. J. Boyko.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 27-34, 8 tab, 5 ref.

Descriptors: *Marine environment, *Canada, *Water quality standards, *Chemical analysis, *Pollutant identification, *Sediments, Polychlorinated biphenyls, Performance evaluation, Hydrocarbons.

The Marine Analytical Chemistry Standards Program was established in 1976 by the National Research Council of Canada in support of analytical aspects of marine chemistry. Part of the mandate of the program has been the development of a series of reference materials for the determination of trace inorganic and organic constituents in marine samples. Among the samples prepared to date are a set of two sediment reference materials for the determination of polychlorinated biphenyls (PCBs). The inorganic sediment reference materials have been freeze-dried, screened, homogenized, bottled, and sterilized. Reliable values are given for 13 trace elements and 12 other constituents. The PCB reference materials have received the same treatment, except for the radiation sterilization. The levels of PCB in these sediments are expressed in parts per million of Arochlor 1254. Values for selected congeners also have been determined. The development of these materials, as well as work underway on the development of a set of five sediment reference materials for polycyclic aromatic hydrocarbon determination, is discussed. (See also W89-06705) (Author's abstract)
W89-06710

COMPUTERIZED DATA MANAGEMENT SYSTEM FOR U.S. EPA QA/QC METHODS,
Acres International Ltd., Niagara Falls (Ontario). Environmental Dept.
For primary bibliographic entry see Field 7C.
W89-06711

VARIOGRAPHIC EXPERIMENT: AN ESSENTIAL TEST FOR OPTIMIZING SAMPLING METHODOLOGY IN MONITORING STREAMS,
Gy (Pierre) and Pitard (Francis) Sampling Consultants, Broomfield, CO.
For primary bibliographic entry see Field 7A.
W89-06712

DEMONSTRATION OF A UNIVERSAL KRIGING PROGRAM FOR MONITORING SEDIMENTS IN LAKES,
Environmental Monitoring and Support Lab.-Cincinnati, OH.
For primary bibliographic entry see Field 7B.
W89-06713

COMPARATIVE STUDY OF METHODS FOR ESTIMATING BIOAVAILABLE PARTICULATE PHOSPHORUS,
Clarkson Univ., Potsdam, NY. Dept. of Civil and Environmental Engineering.
T. C. Young, J. V. De Pinto, and B. J. Hughes.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 69-80, 6 fig, 4 tab, 20 ref. USEPA Assistance Agreement R005761-01.

Descriptors: *Pollutant identification, *Phosphorus, *Sediments, *Bioassay, *Chemical analysis, Great Lakes, Performance evaluation, Algae, Primary productivity, Comparison studies.

A group of chemical and biological procedures for estimating the biologically available phosphorus (BAP) in sediments, representing methods currently used for research around the Great Lakes, were compared among 12 widely different samples of particulate matter from the lower Great Lakes region. The procedures, including one biological and five chemical methods, extracted widely differing amounts of phosphorus from the sediments. Among the procedures, however, the results were highly correlated, indicating the potential for making valid conversions among the estimates, at least for most samples. Analysis of samples held in storage for several years, however, gave results by some extraction procedures that seemed abnormal. Phosphorus extracted by the procedures of Armstrong and others and Baker correlated most closely with bioassay results, whereas that extracted by the procedure of De Pinto and co-workers most closely approximated the amounts of phosphorus taken up by algae during bioassays. (See also W89-06705) (Author's abstract)
W89-06714

CHARACTERIZATION OF TRACE METAL ASSOCIATIONS WITH POLLUTED MARINE SEDIMENTS BY SELECTIVE EXTRACTIONS,
Science Applications International Corp., Narragansett, RI.
W. S. Boothman.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 81-92, 9 fig, 2 tab, 19 ref.

Descriptors: *Path of pollutants, *Heavy metals, *Marine sediments, *Chemical analysis, *Spoil banks, *Long Island Sound, Sediments, Fate of pollutants, Black Rock Harbor, Connecticut, Copper, Cadmium, Chromium, Lead, Organic compounds, Sulfides, Ocean dumping, Chemical reactions.

The biological availability and geochemical fate of toxic metals in materials disposed of in the marine

environment depend in part on the chemical forms in which the metals are present. To characterize the associations of trace metals with particulate matter in polluted marine sediments, samples of dredged materials removed from Black Rock Harbor, Connecticut, and sediments from the disposal site in Long Island Sound (collected subsequent to disposal) were sequentially extracted with a series of solutions. The solutions correspond to a range of conditions under which different sediment phases can be solubilized, and operationally define four sediment fractions: exchangeable, weak acid soluble, oxidizable, and strong acid soluble. In the dredge material, Cd, Cu, and Cr all are predominantly associated with the oxidizable fraction, that is, with sulfides and organic matter, whereas Pb is found primarily in the residual, strong acid soluble fraction. Data from sediment samples collected at the disposal site indicate oxidation of the surface sediments during the warmer months and result in the redistribution of Cd and, to a lesser extent, Cu to the more labile exchangeable and weak acid soluble fractions. Cr and Pb show little evidence of alterations in the binding of those metals to sediments. (See also W89-06705) (Author's abstract)
W89-06715

DISTRIBUTION OF HEAVY METALS IN SEWAGE SLUDGE: THE EFFECT OF PARTICLE SIZE,
Water Research Centre, Medmenham (England). Medmenham Lab.
J. A. Campbell, J. V. Towner, and R. Vallurupalli.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 93-101, 5 fig, 1 tab, 14 ref.

Descriptors: *Wastewater analysis, *Heavy metals, *Particle size, *Sludge, Chromium, Iron, Manganese, Nickel, Copper, Zinc, Cadmium, Lead, Decomposing organic matter, Sorption, Wastewater treatment.

The particle size distribution in two anaerobically digested sludges from contrasting United Kingdom catchments was estimated by a manual sieving technique. Seven particle size fractions were isolated: <20, 20-35, 35-45, 45-64, 64-85, 85-125, and > 125 micrometer. In both samples, the less than 20-micrometer fraction was the largest fraction, accounting for almost 50% of the total. Particles recovered in the coarsest (> 125 micrometer) fraction were distinguished readily as plant remains and cellulose fibers. The distributions of eight metals, Cr, Fe, Mn, Ni, Cu, Zn, Cd, and Pb, were controlled by the particle size distribution, with the finest fraction dominating. However, the distributions of Cr, Cu, Zn, Cd, and Pb (group 1) differed from those of Fe, Mn, and Ni (group 2) in that there was a much wider span of concentration (on a dry weight basis) between coarsest and finest particles. The wide concentration of the metals in group 1 is attributed to repartitioning of these contaminants in sewage from predominantly solution phases to solids, by a sorption process, governed at least to an extent by surface area. On the other hand, Fe, Mn, and Ni (group 2), if predominantly associated with solid phases in raw sewage, would be little influenced by alteration during treatment. (See also W89-06705) (Author's abstract)
W89-06716

EXAMINATION OF METHODS FOR THE CONCENTRATION OF SUSPENDED SEDIMENT FOR DIRECT METAL ANALYSIS,
Geological Survey, Doraville, GA. Water Resources Div.
A. J. Horowitz.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 102-113, 4 tab, 23 ref.

Descriptors: *Suspended sediments, *Sedimentation, *Water analysis, *Trace metals, *Filtration, *Centrifugation, Performance evaluation, Laboratory methods, Comparison studies.

Many laboratories and organizations determine suspended sediment-trace metal concentrations by the method of difference. However, this procedure may lack sufficient sensitivity to accurately and precisely determine suspended sediment metal levels when either metal or suspended sediment concentrations are low. Many of the difficulties associated with the method of difference can be eliminated by or minimized by a direct analysis of suspended sediment. The classical procedure for concentrating (dewatering) suspended sediment entails in-line filtration using preweighed 0.45-micrometer membrane filters; subsequent analysis entails the digestion of the sediment plus filter, analysis of the digestate, and the application of a blank correction for metal contributions from the filters. This procedure can be prohibitively expensive and time consuming, especially when large-scale studies with numerous sampling sites or high sampling frequencies are required. Potential alternative methods of concentration (dewatering) of suspended sediment that could be used in lieu of in-line filtration and for direct quantitation of trace metals while reducing costs were investigated. Three potential substitute procedures, batch centrifugation, settling-centrifigation, and backflush-filtration, were compared to in-line filtration, and were field and laboratory tested. Results indicate that both the batch centrifugation and the settling centrifugation procedures are comparable with in-line filtration and amenable to large-scale sampling and trace metals analysis programs. (See also W89-06705) (Author's abstract)
W89-06717

INTERPRETATION OF BED SEDIMENT TRACE METAL DATA: METHODS FOR DEALING WITH THE GRAIN SIZE EFFECT,
Geological Survey, Doraville, GA. Water Resources Div.
A. J. Horowitz, and K. A. Elrick.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 114-128, 1 fig, 8 tab, 41 ref.

Descriptors: *Sediments, *Water analysis, *Chemical analysis, *Trace metals, *Heavy metals, *Particle size, *Monitoring, Comparison studies, Laboratory methods, Copper, Zinc, Lead, Chromium, Cobalt, Cadmium, Arsenic, Antimony, Selenium, Iron, Manganese, Aluminum, Titanium, Errors.

One of the most significant factors controlling bed-sediment capacity for collecting and concentrating trace metals is grain size: as grain size decreases, metal levels increase. Bed sediment consequently can display marked chemical heterogeneity, even over relatively short distances. The interpretation of water-quality trends through space or time based upon bed sediment-trace metal analysis requires consideration of the grain size effect. Mathematical normalization of bulk chemical data based on an independent grain size analysis can be useful for clarifying trends, but often produce over- or underestimates of metal concentrations. On the other hand, physical separation followed by chemical analysis clarifies trends and produces accurate measurements of metal levels. Based on a detailed grain size and chemical analysis of 17 samples from a wide variety of aquatic settings, and from consideration of factors such as mineralogy, ease of handling, likelihood of contamination, and cost, the most appropriate size separation for reconnaissance surveys or monitoring is < 63 micrometer. When an initial survey or study indicates that a trend or potential problem exists, it is advantageous to isolate the metal-bearing fraction for further study. Although many techniques are available for separating material finer than 63 micrometer into individual size fractions, air elutriation appears to be a method that minimizes such problems as contamination, chemical alteration, and limited masses of separated material. Size distributions obtained by air elutriation are similar to those derived by non-chemically dispersed pipet analyses. Contaminant-free size fractions can be separated from bulk samples for the analysis of Cu, Zn, Pb, Cr, Co, As, Sb, Se, Fe, Mn, Al, Ti, and probably Cd. (See also W89-06705) (Author's abstract)
W89-06718

DEVELOPMENT, EVALUATION, AND USE OF THE TOXICITY CHARACTERISTIC LEACHING PROCEDURES (TCLP),
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
T. A. Kimmell.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 129-140, 3 fig, 2 tab, 14 ref.

Descriptors: *Toxicity Characteristic Leaching Procedure, *Pollutant identification, *Administrative regulations, *Land disposal, *Chemical analysis, Leaching, Toxicity, Comparison studies, Performance evaluation.

The EPA introduced the Toxicity Characteristic Leaching Procedure (TCLP) in an effort to expand the capability of the Extraction Procedure (EP) leaching test to address organic components (including volatiles) and to address some operational problems. The TCLP has been proposed for use in the Land Disposal Restrictions Rule and will soon be proposed in the expansions of the EP Toxicity Characteristic. Both actions were mandated by the Hazardous and Solid Waste Amendments of 1984. The TCLP is described in terms of its development, evaluation, and use. Data are presented regarding precision and ruggedness, and several operational aspects of the procedure are described in detail. Emphasis is placed on a comparison of the existing EP to the TCLP in terms of additional operational and analytical requirements. Aspects of the test being examined for possible improvement also are discussed. (See also W89-06705) (Author's abstract)
W89-06719

DEVELOPMENT OF NEW JERSEY STATE APPROVED METHODS FOR ANALYSIS OF SLUDGE,
New Jersey Dept. of Environmental Protection, Trenton. Bureau of Ground Water Quality Management.
S. H. Dengler.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 141-147, 9 tab, 2 ref.

Descriptors: *Sludge, *New Jersey, *Administrative regulations, *Wastewater analysis, Standards, Performance evaluation, Sludge Quality Assurance Regulations, State jurisdiction, Federal jurisdiction, Land application, Water pollution prevention.

New Jersey, the most densely populated state, produces approximately 2,300,000 dry lb/day of sewage sludge. Half of the sludge is disposed of in the ocean, and the rest is managed through land-based alternatives consisting of agricultural land application, composting, and incineration. Land-based options for sludge management have effects on air, ground, and surface water quality. The New Jersey Sludge Quality Assurance Regulations (SQARs), promulgated in 1979, require wastewater facilities to periodically sample and analyze sludge for certain parameters based on total sewage flow. It was the intent of the regulations to supply the necessary data to determine the quantity, chemical and physical nature, and management mode of the sludge being generated. When the SQARs were promulgated, there were no standardized analytical methods for sludge analysis. A Sludge Methods Task Force, consisting of representatives from academia, major treatment works, industry, and the state and federal government, was created to establish the testing methods. The general procedure adopted by the task force consists of literature and in-house laboratory methods review and conducting intra- and interlaboratory method validation studies. Once finalized as acceptable methods, the task force recommended their incorporation in the state's laboratory certification program as 'approved' methods for the analysis of sludge. (See also W89-06705) (Author's abstract)
W89-06720

USE OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY TO MONITOR SELECTED PRIORITY POLLUTANT LEVELS IN LANDFILL SIMULATOR LEACHATES,
SCS Engineers, Inc., Covington, KY.
For primary bibliographic entry see Field 5E.
W89-06721

METHOD DEVELOPMENT FOR THE DETERMINATION OF FORMALDEHYDE IN SAMPLES OF ENVIRONMENTAL ORIGIN,
Battelle Columbus Div., OH.
M. K. L. Bicking, W. M. Cooke, F. K. Kawahara, and J. E. Longbottom.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 159-175, 7 fig, 5 tab, 6 ref. EPA contract 68-03-1760.

Descriptors: *Formaldehyde, *Chemical analysis, *Pollutant identification, *Chromatography, Phenols, Liquid chromatography, Gas chromatography, Derivatization reagents, Comparison studies, Performance evaluation, Pulp and paper industry.

An analytical method was developed for the determination of formaldehyde in samples of environmental origin. Five candidate methods involving chemical derivatization were evaluated. The derivatization reagents studied were 2,4-dinitrophenylhydrazine (DNPH), 3-methyl-2-benzothiazolinone hydrazone, 2,4-pentanedione, pentafluorophenylhydrazine, and pentafluorbenzyloxyamine. The instrumental techniques used included either high performance liquid chromatography or gas chromatography, depending on the nature of the derivative. After determining that the DNPH derivatization could be efficiently performed under mild reaction conditions, the DNPH method was chosen as the most appropriate of the five considered and was evaluated extensively. Optimized experimental procedures included a 1-hr reaction time, followed by methylene chloride extraction and concentration of the extract. Quantification was best achieved by reverse phase liquid chromatography using absorbance detection at 360 nm. The derivatization of formaldehyde proceeded in high yield with excellent reproducibility and recovery. With the procedures employed, concentrations in the low parts per billion (ppb) range could be determined. Laboratory blank levels were in the 10- to 15-ppb range. An optimized procedure was used in studying several matrices, including two samples originating from the pulp and paper industry: a phenol/formaldehyde sludge and a wood dust sample containing urea/formaldehyde glue. The solid samples were extracted using the toxicity characteristic leaching procedure method. Both matrices showed formaldehyde levels statistically higher then laboratory blanks. Recovery and reproducibility were excellent for solid samples. Matrix and derivative storage problems also were evaluated. (See also W89-06705) (Author's abstract)
W89-06722

TOTAL, EXTRACTABLE, AND LEACHABLE ORGANIC HALIDES IN SOIL AND SEDIMENTS,
Rosemount Analytical Div.-Dohrmann, Santa Clara, CA.
J. T. Martin, and Y. Takahashi.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 176-183, 2 fig, 6 tab, 7 ref.

Descriptors: *Chlorinated hydrocarbons, *Halogenated organic matter, *Groundwater pollution, *Organic halides, *Soil contamination, *Pollutant identification, Microcoulometric titration, Mass balance equation, Water analysis, Soil analysis, Path of pollutants, Carbon adsorption method, Sediments, Monitoring.

The presence of total organic halides (TOX) in soils and sediments is a good indicator that the soil, and possibly the underlying aquifers, are contaminated. Since many halogenated organics are highly toxic to human health, with some being carcinogenic, and naturally occurring organic halides are very limited, their occurrence strongly indicates manmade toxic contamination. Two approaches to TOX analysis of soil are discussed. The first approach investigates a set of soil samples for total halides (TX), inorganic halides IX), and extractable organic halides (EX). The TX are determined by direct combustion of the soil followed by microcoulometric titration of all the halides present in the soil. The IX are determined using a modified version of the method developed by Riggin and co-workers at Battelle Laboratories. The results are then compared to see if the mass balance is true: TX-IX = EOX. The second approach investigates the leachable organic halides (LOX). The LOX is determined by extracting the soil with water and then analyzing the water for TOX by the carbon adsorption method (EPA Method 9020 in SW-846). Together, these investigations demonstrate the utility and flexibility of TOX analysis of soils and sediments. (See also W89-06705) (Author's abstract)
W89-06723

TRACE ORGANIC ANALYSIS OF SUSPENDED SEDIMENTS WITH AN IN-STREAM COMPOSITE SAMPLER: THE NEED FOR A STANDARD METHOD,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
I. H. Suffet, K. Hunchak, A. Wicklund, and T. Belton.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 184-203, 11 fig, 3 tab, 53 ref.

Descriptors: *Standard methods, *Water analysis, *Sampling, *In-stream samplers, *Trace organic compounds, *Water sampling, *Suspended sediments, *Organic compounds, *Pollutant identification, Gas chromatography, Mass spectroscopy, Phenols, Pulp wastes, Plasticizers, New Jersey, Standards, Filtration, Performance evaluation, Quality assurance, Quality control.

Sorption to suspended materials is an important mechanism controlling the transport and fate of nonpolar trace organic chemicals in aquatic environments. To simultaneously examine the aqueous and suspended phases, an in-stream filtration sampler was developed for composite sampling of suspended materials with subsequent extraction of the filtered aqueous phase by XAD resins. The in-stream filtration sampler and broad spectrum analysis were used to evaluate the fate of nonpolar trace organics in a New Jersey river/reservoir/treatment plant system and gas chromatography (GC) and GC/mass spectroscopy (GC/MS) analyses revealed a very different spectrum of compounds in the aqueous and associated suspended sediment phases. In the suspended material extracts, GC/MS tentatively identified alkyl phenols, pulp mill type wastes (long-chain fatty acids, juvabiones, and abietic acid derivatives), and plasticizers. GC/MS analysis of ether extracts of XAD resin tentatively identified petroleum-related polycyclic aromatic hydrocarbons, straight and branched chain aliphatics, and phthalates. Only toluene was found both the aqueous and suspended phases. These data indicate that the suspended material phase and the dissolved phase are not in equilibrium in this particular watershed. An acetone/hexate solvent system was used to soxhlet extract the trace organics present in collected suspended materials. Artifacts, particularly condensation products of acetone, were produced during the filter cleaning and the soxhlet extraction process. The artifacts produced were carefully evaluated and quality assurance procedures assured that they did not interfere with the analysis. The development of an appropriate quality-assured extraction method that minimizes artifact formation is needed for the broad spectrum analysis of nonpolar trace organics associated with suspended materials. (See also W89-06705) (Author's abstract)
W89-06724

DETERMINATION OF POLYCHLORINATED COMPOUNDS (DIOXINS, FURANS, AND BIPHENYLS) BY LEVEL OF CHLORINATION WITH AUTOMATED INTERPRETATION OF MASS SPECTROMETRIC DATA,
Environmental Monitoring and Support Lab.-Cincinnati, OH.
A. L. Alford-Stevens, and W. L. Budde.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 204-212, 6 fig, 4 tab, 4 ref.

Descriptors: *Water analysis, *Pollutant identification, *Chlorinated hydrocarbons, *Mass spectrometry, *Polychlorinated biphenyls, *Dioxins, *Chlorinated dibenzofurans, Gas chromatography, Performance evaluation, Comparison studies, Accuracy, Reliability, Costs, Automation.

A procedure has been developed to identify and measure members of three classes of chlorinated compounds by level of chlorination. These classes are polychlorinated biphenyls, chlorinated dibenzo-p-dioxins, and chlorinated dibenzofurans. A gas chromatograph (GC) equipped with a capillary column and interfaced to a computerized mass spectrometer (MS) was used. Mass spectral data were processed with special software that provides automated determinations. With each class of compounds, MS detector response was calibrated using one isomer to represent all compounds at each level of chlorination. A concentration was measured for each isomer group, and total compound class concentration was obtained by summing isomer group concentrations. Results obtained with the software were compared with results obtained when an experienced analyst using GC/MS data system software to process the same mass spectral data. Automated procedures produced results that were as reliable and accurate as those produced with tedious, labor-intensive human interpretation and computation. (See also W89-06705) (Author's abstract)
W89-06725

ORGANIC CHEMICAL WASTE CHARACTERIZATION FOR MARINE DISPOSAL OF BLACK ROCK HARBOR DREDGED MATERIALS,
Environmental Protection Agency, Narragansett, RI. Environmental Research Lab.
P. F. Rogerson.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 213-222, 5 fig, 4 tab, 13 ref.

Descriptors: *Bioaccumulation, *Bioavailability, *Pollutant identification, *Tissue analysis, *Spoil banks, Marine sediments, Connecticut, Black Rock Harbor, Mussels, Gas chromatography, Mass spectroscopy, Wastewater analysis.

A waste characterization test was designed to determine the actual contaminants in dredged materials that are bioavailable. Unlike many smaller freshwater streams, marine habitats frequently are regulated on the basis of waste bioaccumulation potential. This implies that traditional chemical characterization of sediments may provide data that are not appropriate for marine systems. A waste characterization procedure was sought that would determine those contaminants in sediment that could bioaccumulate. A highly contaminated urban harbor sediment from Black Rock Harbor, Bridgeport, Connecticut, was chosen as the test material. The marine bivalve Mytilus edulis was exposed to suspended dredged material for 28 days in a flow-through exposure system. Exposed organisms then were extracted and analyzed for bioavailable, low-polarity contaminants by gas chromatography/mass spectroscopy (GC/MS). All separable GC/MS peaks were tentatively identified. These tentatively identified contaminants were analyzed subsequently in the dredged material and quantified when appropriate standards were available. Compounds identified by this waste characterization procedure are assured of being both present in the dredged material and biologically available. (See also W89-06705) (Author's abstract)

W89-06726

ANALYSIS OF DIESEL OIL COMPONENTS IN DRILLING FLUIDS,
Centec Analytical Services, Salem, VA.
D. F. Tompkins, E. D. Handel, and W. Telliard.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 223-227, 3 tab, 4 ref.

Descriptors: *Drilling fluids, *Fuel, *Pollutant identification, Bentonite, Distillation, Gas chromatography, Soxhlet extraction, Ultrasonic extraction, Gravimetric analysis, Comparison studies, Performance evaluation.

Three methods of isolating No. 2 diesel oil from a bentonite-based drilling fluid were evaluated: soxhlet extraction, ultrasonic extraction, and retort distillation. The efficiency of each method was demonstrated by either gas chromatography or a determination of the weight or volume of the residue recovered. Only retort distillation demonstrated recoveries greater than 90%. (See also W89-06705) (Author's abstract)
W89-06727

APPLICATION OF ANALYTICAL PYROLYSIS AND CUPRIC OXIDE OXIDATION TO CHARACTERIZATION OF NONEXTRACTABLE ORGANIC CONSTITUENTS IN DRILLING FLUIDS AND SEDIMENTS,
Battelle Ocean Sciences, Duxbury, MA.
T. C. Sauer, A. G. Requejo, J. S. Brown, R. C. Ayers, and P. D. Boehm.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 228-254, 11 fig, 6 tab, 36 ref.

Descriptors: *Drilling fluids, *Sediments, *Pollutant identification, *Organic compounds, Gas chromatography, Cupric oxide oxidation, Lignosulfonates, Bentonite, Barite, Caustic, Pyrolysis, Phenols, Performance evaluation, Comparison studies.

A study was conducted to develop analytical methods suitable for the characterization of nonextractable organic mud additives (organic polymers) in drilling mud formulations and sediments. Analytical pyrolysis involves pyrolysis gas chromatography, whereas cupric oxide oxidation is specific for the analysis of lignin-derived organic matter (lignosulfonates). The pyrolysis technique was suitable for characterizing and distinguishing between individual drilling mud additives. However, upon formulating these additives into drilling muds (bentonite, barite, and caustic) and sediments, their relative abundance and total pyrolysis yields decreased greatly. This decrease in abundance and yields in pyrolysis products is though to be caused by the catalytic and/or sorptive effects of the clay matrix during pyrolysis. As a result, it is concluded that the pyrolysis technique has limited application to the characterization of organic polymers in drilling fluids and sediments. The cupric oxide oxidation technique was a sensitive, specific indicator of lignosulfonates and, to a lesser extent, lignites in mud formulations. The major oxidation products of the technique are vanillyl phenols, with concentrations that vary, presumably according to lignosulfonate purity, but make up more than 90% of the total lignin-derived oxidation products. Vanillyl phenol content and total lignin content were identified as the most suitable tracers of drilling mud discharges. (See also W89-06705) (Author's abstract)
W89-06728

ROUND ROBIN TESTING OF METHODS FOR THE RECOVERY OF HUMAN ENTEROVIRUSES FROM WASTEWATER SLUDGES AND SEWAGE AMENDED SOILS: ASTM CONSENSUS STANDARDS DEVELOPMENT,
Army Biomedical Research and Development Lab., Fort Detrick, MD.
S. A. Schaub.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 265-272, 8 tab, 1 ref.

Descriptors: *Wastewater analysis, *Enteroviruses, *Sludge, *Land application, *Soil analysis, *Standards, American Society for Testing and Materials, Performance evaluation, Comparison studies, Virus recovery, Soil contamination.

The American Society for Testing and Materials Task Groups on Standards Development for Virus-in-Solids (ASTM D19:24:04) has been engaged in the selection of enterovirus recovery methods for sewage sludges and sewage amended soils. Preliminary laboratory screening studies and specific selection criteria were used to identify methods to undergo extensive round-robin comparative methods testing and subsequent standards selection. Virus-in-sludge recovery methods were evaluated first. The sonication-extraction and the low-in-pH-aluminum chloride (AlCl3) methods were selected for round-robin testing. Eight laboratories participated by using five typical sludges and their indigenous enterovirus populations. Although the low pH-AlCl3 method provided a somewhat higher ratio of recovery efficiency in individual tests, there was no statistically significant difference between the methods, and there precisions were essentially identical. Both were recommended as ASTM standard methods. Virus-in-soil recovery methods are being evaluated currently in round-robin tests by nine laboratories using four typical soil types seeded with enterovirus concentrates from raw sewage. The selection criteria and round-robin test protocols are very similar to those used in the sludge methods evaluation procedure. (See also W89-06705) (Author's abstract)
W89-06730

THERMAL INACTIVATION OF HUMAN ENTERIC VIRUSES IN SEWAGE SLUDGE AND VIRUS DETECTION BY NITROSE CELLULOSE-ENZYME IMMUNOASSAY,
Hawaii Univ., Honolulu. Dept. of Microbiology.
For primary bibliographic entry see Field 5D.
W89-06731

RECOVERY OF NATURALLY OCCURRING ROTAVIRUSES DURING SEWAGE TREATMENT,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
V. C. Rao, T. G. Metcalf, and J. L. Melnick.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 282-287, 2 tab, 23 ref.

Descriptors: *Wastewater treatment, *Enteroviruses, *Rotaviruses, *Wastewater analysis, *Biological wastewater treatment, *Pollutant identification, Sludge, Texas, Performance evaluation, Chlorination, Sampling, Culturing techniques.

Human enteric viruses occur in large numbers in sludges and aquatic sediments from polluted waters. Rotaviruses often are involved in water- and food-borne outbreaks. They represent health hazards of undetermined magnitude. Virus levels in sludges may be reduced, but the viruses are not eliminated by aerobic and anaerobic treatment. A study of the removal of indigenous rotaviruses during the primary settling and activated sludge treatment of raw sewage was conducted over 8 mo in a Houston, Texas, plant treating 5.55 million L per day. An average rotavirus reduction of 44-55% was obtained by primary settling and a reduction of 93-99% was achieved in the final chlorinated effluents. Composited sampling at 1-hr intervals of a 24-hr period indicated average removals of 85%, which is much more accurate the misleading average of 6% indicated by one series of grab samples of raw sewage and effluent collected simultaneously. Quantification of rotaviruses was based on counts of immunofluorescent foci 24 hr after addition of sample coverslip cultures of fetal rhesus monkey kidney cells. Rotavirus quantities ranged from 40 to 510/L of raw sewage and from 0-25/L in the final chlorinated effluent. (See also W89-06705) (Author's abstract)
W89-06732

STREAM IMPACT ASSESSMENTS USING SEDIMENT MICROBIAL ACTIVITY TESTS,
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
G. A. Burton.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 300-310, 3 fig, 3 tab, 61 ref.

Descriptors: *Water pollution sources, *Wastewater disposal, *Environmental impact, *Bioindicators, *Toxicity, *Sediments, *Microbial assays, Stream pollution, Environmental effects, Bioassay, Performance evaluation, Wastewater disposal, Test batteries, Municipal wastes, Industrial wastes, Oklahoma, South Dakota, Montana, Utah, Effluents, Enzymes.

Four effluent-impacted streams in Oklahoma, South Dakota, Montana, and Utah were evaluated in collaboration with the U.S. EPA and state agencies. Conventional aquatic test organisms and a battery of microbial activity assays were used as toxicity indicators. Microbial assays of sediment enzyme activity included alkaline phosphatase, amylase, arylsulfatase, electron transport (dehydrogenase), galactosidase, glucosidase, and protease. Study sites received refinery, municipal, and/or mining effluents and showed distinct impact and recovery zones. Significant correlations were observed between sediment enzyme activity and stream biota or chemical measurements of water quality. These positive correlations, at diverse test sites, demonstrate the utility of both short-term microbial assays and the test battery approach in environmental assessments. (See also W89-06705) (Author's abstract)
W89-06734

BIOCHEMICAL CHARACTERIZATION OF ESTUARINE BENTHIC MICROBIAL COMMUNITIES FOR USE IN ASSESSING POLLUTION IMPACTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
For primary bibliographic entry see Field 5C.
W89-06735

TOXICITY TESTING OF DRILLING FLUIDS: ASSESSING LABORATORY PERFORMANCE AND VARIABILITY,
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
R. C. Bailey, and B. P. Eynon.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 334-374, 4 fig, 10 tab, 24 ref, 2 append. EPA Contract 68-01-6912, SAIC Subproject No. 2-834-37-632-XX, Work Assignments E-25 and G-34.

Descriptors: *Quality assurance, *Crustaceans, *Toxicity, *Bioassay, *Drilling fluids, *Pollutant identification, Hydrocarbons, Comparison studies, Performance evaluation, Standards, Environmental Protection Agency, Oil industry, Statistics, Computer programs.

The Analysis and Evaluation and the Industrial Technology Divisions in the Office Water Regulations and Standards and the EPA Gulf Breeze (Florida) Laboratory worked together to develop a protocol for a drilling fluid toxicity test using mysids (Mysidopsis bahia) to support the New Source Performance Standards/Best Available Technology Economically Achievable (NSPS/BAT) Effluent Guideline for the offshore segment of the oil and gas extraction industry. To evaluate the laboratory performance of this toxicity test, the EPA obtained data from 10 laboratories. Each

laboratory applied the toxicity test protocol to an EPA-provided sample of the same well-mixed, pretested batch of drilling fluid. The results of the toxicity test for each laboratory were compared with the results of a concurrent test by the EPA. The statistical procedures for comparison and evaluation of inter- and intralaboratory differences are presented, including a SAS macro package for parametric dose-response models. (See also W89-06705) (Author's abstract)
W89-06737

MARINE SEDIMENT TOXICITY TESTS,
E.V.S. Consultants Ltd., North Vancouver (British Columbia).
P. M. Chapman.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 391-402, 3 tab, 50 ref.

Descriptors: *Water pollution effects, *Marine sediments, *Toxicity, *Bioassay, *Pollutants, *Pollutant identification, Comparison studies, Performance evaluation, Quality assurance, Quality control.

Sediment bioassays provide information on the toxicity of contaminated sediments by measuring the level of their effect on test organisms. Testing involves laboratory exposure of test species to field-collected sediments and can range from the use of whole organisms to individual cells. Exposure routes involve the use of whole sediments, sediment elutriates, or sediment extracts. Except in the case of extracts, sediments cannot be stored and must be tested shortly after collection. Testing methodologies developed to date include most major trophic levels. Measured test responses include acute lethal, sublethal, genotoxic/cytotoxic, and microbial activity measurements. Quality assurance/quality control procedures for collection, handling, and testing have been developed, and an interlaboratory calibration exercise has been completed successfully. Comparative testing of different techniques and routes of exposure indicates a high degree of robustness in the techniques tested to date. (See also W89-06705) (Author's abstract)
W89-06739

TOXICITY TESTING OF DREDGED MATERIALS USING MULTIPLE-SPECIES MICROCOSMS,
Old Dominion Univ., Norfolk, VA. Applied Marine Research Lab.
R. W. Alden, and A. J. Butt.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 418-437, 6 fig, 4 tab, 18 ref. Corps of Engineers contract DACW65-81-C-0051.

Descriptors: *Toxicity, *Bioassay, *Spoil banks, *Microcosms, *Water pollution effects, Ecological communities, Zooplankton, Benthos, Animal behavior, Virginia, Sediments, Hydrocarbons, Metals, Tissue analysis, Bioaccumulation.

Microcosm experiments were conducted to evaluate the relative toxicity of sediments taken from dredge sites in the Port of Hampton Roads, Virginia. The multiple-species microcosms were designed to allow natural assemblages of zooplankton and benthos to be exposed to dredged materials under more realistic conditions than achieved in bioassays. Changes in community structure and body burdens of contaminants were monitored in the microcosms following 'dumps' of the sediments. The biological effects of exposure to dredged materials under the microcosm conditions were subtle. Zooplankton community structure was affected only by treatments involving sediments known to be most contaminated with polynuclear aromatic hydrocarbons and metals. Likewise, statistically significant changes were observed in the composition of benthic communities exposed to the most contaminated sediments. Motile forms appeared to have migrated from the contaminated sediments in various degrees while more sedentary species displayed mortalities compared to the controls. Body burden studies indicated that experimental animals did not accumulate significant concentrations of metals or chlorinated hydrocarbons in any of the treatments. However, biota exposed to the contaminated sediments did accumulate certain of the polynuclear aromatic hydrocarbons known to be major pollutants in the port. (See also W89-06705) (Author's abstract)
W89-06741

SELECTING AN APPROPRIATE METHOD FOR ESTIMATING THE SEDIMENT OXYGEN DEMAND RATE,
Georgia Univ., Athens. Inst. of Natural Resources.
K. J. Hatcher.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 438-449, 4 fig, 1 tab, 16 ref.

Descriptors: *Water analysis, *Oxygen demand, *Sediments, Dredge spoil, Training, Chemical oxygen demand, Cost analysis, Model studies, Comparison studies, Performance evaluation, Pollutant identification.

A summary and assessment is given of eight methods used by various researchers for estimating the sediment oxygen demand SOD rate. Topics covered include a definition of the SOD rate and its importance and the in-stream processes that affect the SOD rate and thus complicate efforts to measure it. The eight methods, which are reviewed in terms of precision, time requirements, and training requirements, are: in-situ chambers, the laboratory method for intact cores, laboratory measurement of dredged sediment samples, interstitial COD gradient, literature values, regression equations, model calibration, and SOD process models. A logical procedure is suggested for determining the appropriate measurement precision and budget for SOD data collection. These precision and budget specifications can guide the selection of an appropriate method for measuring SOD rates for a particular water quality modeling study. (See also W89-06705) (Author's abstract)
W89-06742

USE OF BENTHIC OXYGEN FLUX MEASUREMENTS IN WASTELOAD ALLOCATION STUDIES,
Environmental Protection Agency, Chicago, IL. Region V.
W. S. Davis, T. M. Brosnan, and R. M. Sykes.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 450-462, 3 fig, 6 tab, 20 ref.

Descriptors: *Water analysis, *Wastewater analysis, *Municipal wasteload allocations, *Pollution load, *Dissolved oxygen, *Benthic oxygen flux, Scioto River, Ohio, Prediction, Weather, Photosynthesis, Algae, Plankton, Model studies.

Effects of benthic activities on stream oxygen balances are often overlooked in municipal wasteload allocations (WLAs). To improve dissolved oxygen (DO) concentration predictions for the central Scioto River, Ohio, benthic oxygen flux (BOF) rates were incorporated into the QUAL-2e water quality model by measuring the BOF rates in situ with opaque and translucent hemispherical chambers under the low-flow conditions of late September 1985. The average light and dark chamber BOF rates were 6.46 g O2/sq m/day and -2.74 g O2/sq m/day, respectively. The net BOF rate applied to the model was 1.74 g O2/sq m/day, corrected for water column demands. Measurements conducted during variable weather conditions showed a strong influence of cloud cover on BOF rates. The inclusion of the BOF term in the calibrated model resulted in a predicted DO increase as high as 1.15 mg/L in some stream segments, compared with 0.08 gm/L for planktonic photosynthesis. The BOF rates used in the QUAL-2e WLA model improved the DO predictions for the Scioto River. (See also W89-06705) (Author's abstract)
W89-06743

MICROBIOLOGICAL RISK ASSESSMENT FOR LAND APPLICATION OF MUNICIPAL SLUDGE,
Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5E.
W89-06746

ASSESSMENT OF RISKS ASSOCIATED WITH ENTERIC VIRUSES IN CONTAMINATED DRINKING WATER,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
C. P. Gerba, and C. N . Haas.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 489-494, 1 fig, 3 tab, 24 ref.

Descriptors: *Drinking water, *Enteroviruses, *Risks, *Human diseases, Mortality, Probabilistic process, Prediction, Public health.

Few attempts have been made to assess the risks associated with exposure to low numbers of enteric viruses in the environment. To determine the risks that may be associated with exposure to human enteric viruses, the literature on minimum infectious dose, incidence of clinical illness, and mortality was reviewed. This information was used to assess the probability of infection, illness, and mortality for individuals consuming drinking water containing various concentrations of enteric viruses. Risks were determined on a daily, annual, and lifetime basis. This analysis suggested that significant risks of illness (> 1:10,000) and mortality (> 1:1,000,000) may arise from the exposure to low levels of the enteric virus in drinking water. (See also W89-06705) (Author's abstract)
W89-06747

ORGANIC MICROPOLLUTANTS IN THE AQUATIC ENVIRONMENT: PROCEEDINGS OF THE FIFTH EUROPEAN SYMPOSIUM, HELD IN ROME, ITALY, OCTOBER 20-22, 1987.
Kluwer Academic Publishers, Boston, MA. 1988. 452 p. Edited by G. Angeletti and A. Bjorseth.

Descriptors: *Water pollution, *Water treatment, *Pollutant identification, *Fate of pollutants, *Path of pollutants, *Model studies, Aquatic environment, Water management, Groundwater pollution, Surface water, Municipal water, Water supply, Environmental quality, Gas chromatography, Spectrometers, Organic compounds.

Papers and posters presented at the 'Fifth European Symposium on Organic Micropollutants in the Aquatic Environment' discuss matters related to Concerted Action COST 641 which is part of the Fourth R and D Programme on the Environment of the Commission of the European Communities. These proceedings provide an overview of the current studies and technical progress in the area of organic micropollutants in the aquatic environment, as they pertain to Europe, since the last symposium in October 1985. The papers are related to analytical methodologies such as low-cost mass spectrometry and steam distillation-extraction, transport and transformation of organic micropollutants in water, water treatment processes and mathematical modeling, including some chemical fate and transport modeling. Special sessions were devoted to laboratory data treatment and environmental scenarios. (See W89-06749 thru W89-06800) (Author's abstract)
W89-06748

USE OF LOW-COST MASS SPECTROMETERS FOR THE ANALYSIS OF ORGANIC MICROPOLLUTANTS IN WATER,
S. P. Scott, R. L. Keeling, H. James, A. Waggott, and P. Whittle.
IN: Organic Micropollutants in the Aquatic Envi-

ronment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 2-13. 3 fig, 2 tab, 3 ref.

Descriptors: *Water analysis, *Spectrometers, *Pollutant identification, *Gas liquid chromatography, *Organic pesticides, Pesticides, Laboratories, Economic aspects, Organic compounds, Phenols, Triazines.

Mass spectrometry in combination with gas chromatography (GC-MS) has been applied to the analysis of organic compounds in water for over a decade. Initially, because of the high costs involved, only a few central research laboratories possessed such equipment. However, in the last few years, manufacturers have produced smaller bench-top mass spectrometers at lower prices so that GC-MS facilities have become more widely available. The UK water undertakings have, collectively, considerable experience of the two most commonly available bench-top GC-MS systems - the Finnigan Ion Trap Detector (ITD) and the Hewlett-Packard Mass Selective Detector (MSD). Typical applications of these two systems to the analysis and monitoring of various organics, including phenols, pesticides, triazines, and geosmin are described. Factors such as ease of use, reliability, and the quality of the data produced by the ITD and MSD are discussed. The versatility of the ITD and MSD will bring about, as methods are developed, an overall reduction in the total number of GC's needed within a laboratory and therefore a saving in time, money and space. They also allow the larger mass spectrometers that may be present in a group to be used more gainfully, e.g. accurate mass measurement and linked scans. (See also W89-06748) (Author's abstract)
W89-06749

COUPLING MICRO-LC CAPILLARY GC AS A TOOL IN ENVIRONMENTAL ANALYSIS,
RSL-Allteck Europe, Eke (Belgium).
D. Duquet, and C. Dewaele.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 14-21. 6 fig, 34 ref.

Descriptors: *Water analysis, *Gas chromatography, *Pollutant identification, *Chemical analysis, Sampling, Trace elements, Materials testing.

A multidimensional chromatography system with a packed fused silica Micro-LC column connected on-line with a capillary GC column is described. The Micro-LC column can act as a sample clean-up and/or a chemical class separation column prior to introduction of the sample into the capillary GC column. This technique was used for analyzing complex mixtures and/or trace compounds in complex matrices. The typical low flow rates of the Micro-LC system allow loading of the entire LC peak volume into the capillary GC column. The use of a retention gap allows the injection of several microliters without loss in resolution or bad peak shape of the components of interest. The Micro-LC system is very selective and can be used in the straight phase, reversed phase or size exclusion model. The Micro-LC column can act as a concentration column, a sample clean-up column or as a group separation column prior to CGC analysis. For many applications, sample preparation times are reduced and detection limits are decreased. (See also W89-06748) (Friedmann-PTT)
W89-06750

STANDARDIZED ANALYTICAL METHODS FOR EC PRIORITY POLLUTANTS,
S. Schmidt.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 22-30. 1 tab, 6 ref.

Descriptors: *Standard methods, *Priority pollutants, *Water analysis, *Sample preservation, *Pollutant identification, *Chemical analysis, *Halogenated pesticides, *Benzenes, *Hydrocarbons, *Organic compounds, Laboratories, Halogens, Gas chromatography, Volatility.

Progress being made in the analysis of the 129 EC priority pollutants (easily volatile halogenated hydrocarbons, benzene and derivatives, chloroethene, phenolic compounds, polycyclic aromatic hydrocarbons) is discussed. Except for dichloromethane, the results of two interlaboratory trials, analyzing easily volatile halogenated hydrocarbons, were fairly satisfying. Only a few of the 18 participating laboratories have tried to analyze dichloromethane; most of them reported far too high values. Thus, the method used in the analysis is not suitable for the determination of dichloroethane in low concentrations. As for analysis of benzene and derivatives, the extraction procedure and head space method used in laboratory trials may not yield the same results. With benzenes, interferences by suspended matter or emulsifiers will be smaller when applying the head space method instead of the extraction procedure. Laboratory analysis of chlorethene included head space gas chromatography. In the case of distilled water spiked with 15 micrograms/L, recovery rate of 95% and a repeatability standard deviation SR of 2.99 micrograms/L and a reproducibility standard deviation of 0.70 micrograms/L were achieved. For phenolic compounds, gas chromatography was carried out using two capillary columns of different polarity and stationary phases installed in one injector. In most cases, a flame ionic detection, or, in the case of polychlorinated phenols, an electron capture detection was used. The HPLC method for the determination of polycyclic aromatic hydrocarbons was used; values from interlaboratory trials are not yet available. Compared with earlier trial results, only little progress was made with the current series, due mainly to the extremely high number of fluoroocompounds and organochlorinated hydrocarbons produced and registered. (See also W89-06748) (Friedmann-PTT)
W89-06751

APPLICATION OF BONDED SILICA EXTRACTION COLUMNS IN SAMPLE PREPARATION PRIOR TO THE ANALYSIS OF ORGANIC MICROPOLLUTANTS IN WATER,
Analytichem International, Cambridge (England).
R. A. Calverley.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 31-44. 4 fig, 7 tab, 10 ref.

Descriptors: *Water analysis, *Pollutant identification, *Organic compounds, *Chemical analysis, *Ion exchange, *Silica, *Extraction, Sampling, Laboratories, Cleanup operations, Pesticides, Herbicides, Priority pollutants, Halogenated pesticides.

For many applications involving the extraction, concentration and purification of organic micropollutants from water samples, the use of bonded silica extraction columns can be a valuable alternative to traditional sample preparation techniques such as liquid-liquid extraction. The commercial availability of a wide range of bonded silica sorbents means that extraction and clean-up procedures can now be developed utilizing non-polar, polar and ion exchange mechanisms. The characteristics of some of these bonded silicas and the nature of the interactions that are possible between the sorbents and organic compounds with which they are capable of interacting are described, including non-polar, polar, and ionic interactions. Details of the procedure for the preparation of the extraction columns prior to use are given, with some examples of the uses of a variety of different sorbents in the extraction, purification and concentration of organic pollutants, such as organochlorine pesticides, neutral and acidic EC priority pollutants, herbicides, and polynuclear aromatic hydrocarbons, from water cited. (See also W89-06748) (Friedmann-PTT)
W89-06752

EVALUATION OF STEAM DISTILLATION-EXTRACTION PROCEDURE FOR THE RECOVERY OF PHENOLS IN WATER,
Barcelona Univ. (Spain). Dept. of Analytical Chemistry.
M. T. Galceran, and F. J. Santos.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 46-51. 2 fig, 1 tab, 21 ref.

Descriptors: *Pollutant identification, *Water analysis, *Phenols, *Extraction, *Vapor compression distillation, *Distillation, Ion exchange, Reagents, Chemical properties, Polarity, Solvents.

The quantitative performance of steam distillation extraction for the isolation of nine priority pollutant phenols from water was studied, and the recoveries compared with those of the direct extraction with dichloromethane and the two step extraction using tetrabutylammonium as ion-pair reagent. For a concentration of 1 mg/L using acidification, strong salting of the water sample and a distillation time of 1.5 h, the recoveries were similar to those obtained with extraction in acidic medium with dichloromethane. Compounds of high polarity, with strong interactions with water by hydrogen bonds, as p-nitrophenol, are not extracted by the stream distillation-extraction method. Advantages of the stream-distillation method are the dual isolation of phenols that diminished the simultaneous extraction of interfering compounds and the relatively small amount of solvent used that prevents solvent contamination. A disadvantage is the low recoveries for compounds as the p-nitrophenol and other nitro and amino phenols that can be extracted by the direct extraction method. (See also W89-06748) (Friedmann-PTT)
W89-06753

ISOMER-SPECIFIC DETERMINATION OF PCDD/PCDF IN WATER LEACHATE OF A WASTE LANDFILL,
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.).
C. Forst, L. Stieglitz, and G. Zwick.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 52-58. 3 fig, 3 tab.

Descriptors: *Dioxins, *Cleanup operations, *Pollutant identification, *Chemical analysis, *Organic compounds, *Landfills, *Hazardous materials, Groundwater pollution, Leachates, Sampling, Gas chromatography, Isomers, Industrial wastes, Chemical wastes.

A clean-up procedure for the isomer-specific analysis of polychlorinated dibenzodioxins (PCDDs) and dibenzofurans (PCDFs) in oil extracts from water leachate of a hazardous waste landfill is described. The samples were chromatographed on Lumina B-Super I, silica gel combined with silica gel/44% conc. H2SO4 and on Bio Beads S-X3. Separation of 2,3,7,8-tetra-CDD and final sample purification were performed on Alumina B-Super I (micro column). Among the 2,3,7,8-tetra- to hexa-CDDs/CDFs, 2,3,7,8-TCDD was by far the most abundant isomer, determined at a mean concentration of 70.5 ppb. Industrial wastes from 2,4,5-trichlorophenol production are assumed to be the main source for this high concentration. From the isomer distribution pattern of the hepta-CDFs, pentachlorophenol can be considered as source of the higher chlorinated PCDDs/PCDFs. (See also W89-06748) (Author's abstract)
W89-06754

TECHNIQUES FOR THE IMPROVEMENT OF GASOLINE ANALYSIS,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.
P. Slingerland, and R. C. C. Wegman.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 62-67. 2 tab, 13 ref.

Descriptors: *Gasoline, *Pollutant identification, *Chemical analysis, *Water analysis, *Gas chromatography, Chemical properties, Data acquisitions, Sampling.

For the automated analysis of gasoline components in water samples, a gas chromatograph equipped with a multifunction controller, an on-column autosampler and a data acquisition system was used. Use of retention indices improves the reliability of the identification. However, components that differ less than 0.7 index units could not be discriminated by the available acquisition software. Further improvements of retention indices with the described equipment are not possible. Improvement of the GC-equipment is less important. A more accurate retention time registration is necessary. Control runs with GC-MS are recommended. Pattern recognition techniques could be helpful to avoid serious mistakes in identification and quantitation. (See also W89-06748) (Author's abstract)
W89-06756

IMPROVED EXTRACTION METHOD FOR THE QUANTITATIVE ANALYSIS OF PESTICIDES IN WATER,
Bonn Univ. (Germany, F.R.). Hygiene Inst.
H. F. Schoeler, and J. Brodesser.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 69-74. 2 fig, 2 tab, 13 ref.

Descriptors: *Organic pesticides, *Pollutant identification, *Chemical analysis, *Pesticides, *Water analysis, *Extraction, *Gas chromatography, *Quantitative analysis, Sampling, Chemical properties, Laboratories, Solvents, Detection limits, Surface water, Groundwater pollution, Halogenated pesticides.

A new method for the enrichment of pesticide residues in water by liquid/liquid extraction with n-pentane in a light phase rotation perforator according to Ludwig is described. Altogether, 44 compounds (chloropesticides, urones, triazines, phosphoric acid esters and others) were analyzed at given concentrations by gas chromatography. Four phosphoric acid esters and two other compounds showed insufficient recovery rates between 50% and less than 10% due to their decomposibility in aqueous solutions. All other analyzed substances showed very good average recoveries of 80% to 115%. Detection limits ranged from 10 to 100 ng/L, dependent on the detectors (ECD, PND) and enrichment factor (1000 and 2000, respectively). The applicability of this enrichment method to residue analysis of pesticides in surface water and groundwater is demonstrated. Among its advantages are the fact that it offers fast exhaustive extraction in 30 minutes by a nonpolar solvent. Also, without changing solvent, different types of GC-detectors can be utilized. The extraction can be carried out within the sampling vessel by a simple modification of the rotation perforator. Loss by adsorption on glass walls can be avoided. (See also W89-06748) (Friedmann-PTT)
W89-06757

HYPHENATED METHODS (TSP LC-MS, DLI LC-MS, LC-TID) FOR ANALYZING ORGANOPHOSPHORUS PRIORITY POLLUTANTS,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Dept. of Environmental Chemistry.
D. Barcelo, and J. Albaiges.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 75-82. 5 fig, 35 ref, append.

Descriptors: *Water analysis, *Organophosphorus pesticides, *Pollutant identification, *Chemical analysis, *Organic pesticides, *Pesticides, *Spectrometers, *Gas liquid chromatography, Sampling, Laboratories, Water pollution, Organic compounds.

The coupling of several analytical techniques via appropriate interfaces for monitoring selected organophosphorus pesticides (OPs) included in the EEC list of priority pollutants is illustrated. By utilizing positive and negative ion (PI and NI, respectively), 'filament on' thermospray liquid chromatography-mass spectrometry (TSP LC-MS) and positive and negative chemical ionization (PCI and NCI, respectively) in direct liquid introduction (DLI) narrow-bore LC-MS, with acetonitrile-water mixtures, the characterization of several OPs is achieved. The use of 1% chloroacetonitrile in the LC mobile phase in DLI LC-MS is also discussed. Reversed-phase narrow-bore LC coupled to a thermionic detector (LC-TID) is carried out with methanol-water mixtures as eluent. Applications are reported for the determination of OPs in aquatic environments. The combination of PI and NI in TSP and the use of PCI, NCI and CLENI in DLI provided unequivocal information about the OPs. For trace determinations of the OPs, PI should be preferred to NI, in TSP, and NCI and CLENI to PCI, in DLI. Picogram levels can be detected as in GC-NCI MS, but with simpler clean-up procedures. Because of the numerous cluster ions in the reagent gas spectrum, TSP LC-MS needs to start scanning from higher mlz values than in DLI. The LC-TID system showed detection limits of about 40 pg for OPs using a flow rate of 40 microliters/min with methanol-water mixtures. (See also W89-06748) (Friedmann-PTT)
W89-06758

HPLC/FLUORESCENCE SPECTROMETRY IN ANALYSES OF PULP MILL WASTES IN RECIPIENTS,
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
P. Mikkelson, J. Paasivirta, and J. Knuutinen.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 88-90. 1 fig, 3 ref.

Descriptors: *Pollutant identification, *Fluorometry, *Humic acids, *Pulp wastes, *Water analysis, Spectrometers, Extraction, Chemical analysis, Industrial wastes.

A method for the determination of lignin and humic substances in water by HPLC with fluorimetric detection is presented. Water samples are extracted with ethyl acetate and the carboxylic acids in these extracts are labeled with 4-Br-MMC. Results indicate that this method might be applicable to characterization of humic waters and differentiation of humic and lignin compounds in recipient waters of pulp mills. (See also W89-06748) (Author's abstract)
W89-06760

CHLOROPHENOL COMPOUNDS IN SNOW,
Jyvaeskylae Univ. (Finland). Inst. for Environment Research.
R. Paukku, J. Paasivirta, M. Knuutila, and S. Herve.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 91-96. 3 fig, 2 tab, 5 ref.

Descriptors: *Path of pollutants, *Phenols, *Polychlorinated biphenyls, *Snow, *Finland, Sampling, Laboratories, Gas chromatography, Chemical analysis, Pollutant identification.

Levels of polychlorinated phenols, guaiacols and catechols were studied in snows from the North Pole, North, Central, and South Finland. One liter of water (melted from snow) was taken, and a measured amount of 2,3,6-trichlorophenol was added to make an internal standard. Potassium carbonate was added to make the solution 0.1 molar, and then shaken 5 minutes with 5 ml acetic anhydride. Then, 5 ml of hexane was added and the sample shaken again 5 min. The hexane layer was evaporated and injected to a gas chromatograph, equipped with two non-identical columns (OV-1701 and SE-54), both leading to ECD. The retention times of both columns had to match those of authentic reference compounds. Gas chromatography was performed using helium as the carrier gas. Only Central and South Finland samples contained known compounds above the detection limit of 0.5 ng/L. Airborne chlorophenol pollution appeared to be much higher in South than in Central Finland. (See also W89-06748) (Friedmann-PTT)
W89-06761

ANALYSIS OF ODOROUS SULPHFUR COMPOUNDS BY GAS CHROMATOGRAPHY AFTER THERMAL DESORPTION FROM TENAX,
I.W. Davies, and J. Yates.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 97-102. 2 fig, 3 ref.

Descriptors: *Gas chromatography, *Volatility, *Sulfur compounds, *Pollutant identification, Odors, Wastewater treatment, Chemical analysis, Laboratories, Flame photometry, Spectrometers.

An analytical method for volatile sulfur compounds, which arose from the need to monitor compounds known to cause nuisance odors in the atmosphere near sewage treatment works, was evaluated. The technique uses thermal desorption from Tenax adsorbent, cold trapping and transfer on to a capillary GC column before chromatography and has been applied to qualitative analysis of a broad range of organic compounds by gas chromatography-mass spectrometry. The technique was modified to meet the demands of the analysis of a range of reactive volatile sulfur compounds by GC using a sulfur-selective flame photometric detector. Factors affecting recoveries from the adsorbent were identified, and efficiency of transfer significantly improved. In addition to Tenax GC, six other adsorbents were investigated: silylated Tenax GC, Tenax TA, silylated Tenax TA, activated carbon, Porapak QS, and Carbopack B coated with 1.5% XE60/1% H3PO4. None of these materials led to an improvement in transfer efficiency. (See also W89-06748) (Friedmann-PTT)
W89-06762

ORGANIC PHOSPHATES IN SURFACE, GROUND AND DRINKING WATER,
Istituto di Ricerca sulle Acque, Milan (Italy).
S. Galassi, and L. Guzzella.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 108-115. 1 fig, 4 tab, 9 ref.

Descriptors: *Water analysis, *Water treatment, *Organic compounds, *Pollutant identification, *Phosphates, *Drinking water, *Water analysis, *Italy, Potable water, Water pollution, Quantitative analysis, Herbicides, Esters, Chemical analysis, Surface water, Groundwater pollution, Po River, Lake Como, Adige River, Filtration, Activated carbon.

During a survey undertaken in 1986 for triazine herbicide determination in surface and drinking water in Northern Italy, phosphate esters were found as ubiquitous interfering compounds, using the GLC technique with a nitrogen/phosphorus-specific detector. As these compounds occurred very frequently at levels higher than herbicides, they were identified and quantitatively determined. TBP (tri-n-butylphosphate), TIBP (tri-iso-butylphosphate) and TCEP (tris-2choroethylphosphate) and TCEP (tris-2chloroethylphosphate) were very frequent in river Po, river Adige and Como lake waters, as well as in drinking waters derived from these surface supplies. Groundwater was much less polluted. Treatment processes could reduce this contamination: filtration on activated carbon was a very efficient system. However, reduction of this pollution at the source, at least for the most dangerous compounds, should be the most convenient policy. (See also W89-06748) (Author's abstract)
W89-06764

EVALUATION OF DEGREE OF POLLUTION OF TIBER AND ANIENE RIVERS BY NITRILOTRIACETIC ACID,

Rome Univ. (Italy). Dept. of Chemistry.
L. Zoccolillo, G. P. Cartoni, M. Ronchetti, and A. Delogu.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 116-120. 2 fig, 1 tab, 5 ref.

Descriptors: *Water analysis, *Pollutant identification, *Water pollution sources, *Quantitative analysis, *Detergents, *Sodium compounds, Acidic water, Gas chromatography, Extraction, Rivers, Public health, Stream pollution, Rome, Italy, Tiber River, Aniene River.

The sodium salt, nitrilotriacetic acid (NTA), has been recognized as the most suitable substitute for sodium tripolyphosphate in detergents. NTA introduction on a large scale, however, has been much questioned due to fears of its possible health effects and its impact on the environment. To evaluate the degree of pollution by NTA of the Tiber and Aniene rivers (Italy), sampling was carried out in three different periods of 1987. The analytical procedure involved extraction from water, conversion to trimethylester, and analysis by capillary gas chromatography. As expected, the NTA concentration increases in both rivers when they pass through the city of Rome. (See also W89-06748) (Friedmann-PTT)
W89-06765

MONITORING OF THE RIVER RHEIN - EXPERIENCE GATHERED FROM ACCIDENTAL EVENTS IN 1986,

H. Friege.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 132-143. 4 fig, 2 tab, 14 ref.

Descriptors: *Water pollution control, *Rhine River, *Monitoring, *Stream pollution, *Water quality, *Water analysis, *Pollutant identification, *Water quality control, Water pollution, Sampling, Chemical wastes, Drinking water.

Water quality of the river Rhine has been gradually improving compared to the situation in the 70s. Thus, more sensitive aquatic organisms are now settled in the water body and the banks of the river. Therefore, accidental events are now more important for the river, possibly causing a deterioration in the water quality. More importantly, drinking water supply may be endangered. In 1986, a number of contamination events in the Rhine river were reported, most of them caused by accidents in chemical production plants. The monitoring strategy for the Rhine in Nordrhein-Westfalen has proven to be successful, and the monitoring system should be enhanced. For rapid detection of contaminants in the river, monitoring activities include sensitive chemical screening methods as well as biological tests. In order to control waste water and cooling water discharge, automated analytical systems should be installed directly at the discharge points of a chemical production plant to detect irregularities as fast as possible. Moreover, chemical companies should be required to install samplers that work automatically. As decisions have to be taken very quickly, valid data on the behavior of all possible and relevant contaminants with respect to raw water purification should be available on-line. (See also W89-06748) (Author's abstract)
W89-06768

POLLUTION OF SARONICOS GULF (ATHENS, GREECE) BY FOSSIL FUEL HYDROCARBONS,

NRC Democritos, Athens (Greece).
A. Mylona, N. Mimicos, and E. Stephanou.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 184-188. 6 fig, 1 tab, 5 ref.

Descriptors: *Water pollution sources, *Oil pollution, *Hydrocarbons, *Chemical analysis, *Sampling, *Pollutant identification, *Petroleum products, Sediment sampler, Organic compounds, Greece, Spectrometers, Extraction, Fluorometry.

Sediments sampled within Saronicos gulf (Greece) were used as geoaccumulators for the assessment of the status of petroleum pollution in this area. Molecular markers were studied to identify the source of this pollution. Samples of the sediment surface were taken in 1986 at locations in the Gulf. All sediment samples were collected by a 0.1 sq. m Van Veen grab sampler; water was allowed drain to off and the samples were wrapped in aluminum foil and stored at -15 C until analysis. Samples were freezed-dried and sieved through a 200 mesh sieve. 5-20 g of the 200 mesh homogenated sediment samples were saponified with methanolic KOH for 1.5 hrs followed by extraction with n-pentane. Alkanes were separated from aromatics using an Alumina S.G./column. A Finnigan mass spectrometer Model 4000 with an INCOS 2000 data system was used for mass spectrometric determinations. Helium was used for the carrier gas with a back pressure of 0.8 atm. Results were compared with those obtained from a spectrofluorometric analysis. The presence of a wide range of aromatic compounds was typical of the aromatic composition of petroleums. The n-alkane distribution exhibited a bimodal profile, with the first mode ranging between n-C 20 and n-C 26, and the second ranging between n-C 27 and n-C 35. Such a distribution indicated a crude oil contribution and a terrestrial plant wax input. (See also W89-06748) (Friedmann-PTT)
W89-06773

LEVELS OF CHLOROPHENOLS IN THE RIVER, GROUND, AND DRINKING WATER IN THE ZAGREB AREA,

Zagreb Univ. (Yugoslavia). Inst. for Medical Research and Occupational Health.
S. Fingler, and V. Drevenkar.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 238-242. 1 fig, 2 tab, 9 ref.

Descriptors: *Water pollution sources, *Zagreb, *Yugoslavia, *Organic compounds, *Phenols, *Groundwater pollution, *Drinking water, Pollutant identification, Quantitative analysis, Sampling, Stream pollution, Groundwater, Water analysis, Chemical analysis, Water treatment, Sava River.

The presence of 4-chloro-, 2,4-dichloro-, 2,4,5- and 2,4,6-trichloro-,2,3,4,6-tetrachloro and pentachlorophenol was investigated in samples of Sava River water and of ground and drinking water collected in the Zagreb area. In almost all of the 25 river water samples, higher chlorophenols were detected, with pentachlorophenol present in highest concentrations, but not exceeding 160 ng/cu dm. The levels of chlorophenols in groundwater samples collected in 18 wells depended on the location and distance of the well from the Sava River bed. Their presence in the river water did not appear to have an effect on the purity of ground water sampled from wells about 2 km away from the river, among which ten were supplying water to the Zagreb waterworks. However, single chlorophenols were detected in samples of both chlorinated municipal drinking water and non-chlorinated drinking water from privately-owned wells. The occurrence of chlorophenols in drinking water samples seemed to be mainly a consequence of occasional contamination of groundwater in the city of Zagreb, where waterworks pump stations and private wells are located in certain city areas, often near industrial plants. (See also W89-06748) (Author's abstract)
W89-06780

BIOLOGICAL-CHEMICAL CHARACTERIZATION OF EFFLUENTS FOR THE EVALUATION OF THE POTENTIAL IMPACT OF THE AQUATIC ENVIRONMENT,

National Swedish Environment Protection Board, Solna. Emission and Product Control Lab.
O. Svanberg, and L. Renberg.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 244-255. 4 fig, 4 tab, 8 ref.

Descriptors: *Bioindicators, *Effluents, *Industrial wastewater, *Pollutant identification, *Water pollution effects, Aquatic environment, Biological properties, Hazardous materials, Sweden, Permits, Regulatory agencies, Environmental quality, Environmental protection.

The approach to using integrated programs of biological and chemical tests for characterization of industrial effluents, that has been applied for hazard assessment by the regulatory agencies of Sweden for some years is described. Most cases are connected to the claim on municipal and industrial facilities to obtain discharge permits. In other cases, testing programs have been used for directing process modifications or external treatment techniques towards a minimization of the environmental effects of the discharge. The biological testing has found the widest and most efficient application for industrial plants with processes emitting complex effluents with largely unknown chemical composition and environmental impact. The test programs are applied in a flexible manner depending on the type of industry with its process modifications, raw materials and chemicals added. The character of the receiving water body is taken into consideration when choosing the test organisms. (See also W89-06748) (Author's abstract)
W89-06781

PRESENCE OF POLYCYCLIC AROMATIC HYDROCARBONS IN SURFACE WATERS USED FOR THE PRODUCTION OF DRINKING WATER,

Antwerpse Waterwerken (Belgium).
F. Van Hoof, and S. Aerts.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 318-322. 3 fig, 1 tab, 2 ref.

Descriptors: *Hydrocarbons, *Pollutant identification, *Extraction, *Drinking water, *Water treatment, Surface water, Filters, Economic aspects, Comparison studies, Suspended load, Particulate matter, Sedimentation.

Two methods widely applied for isolating polycyclic aromatic hydrocarbons (PAH) from surface water are compared: solvent extraction using cyclohexane, and solid surface extraction. Higher recoveries were obtained through solvent extraction, while the reproducibility for both methods was similar. In spite of the higher costs, solvent extraction was selected for further use. Results obtained on surface water samples were strongly influenced by the presence of suspended material. PAH were shown to be mainly associated with the larger suspended particles, which are removed easily through sedimentation in impoundmeat reservoirs. The results obtained stress the need for clearly identifying the sample type (filtered or not) and the sampling point (before or after impoundment) when performing this analysis for evaluating water quality in relation to legal requirements. (See also W89-06748) (Author's abstract)
W89-06788

MASS SPECTROMETRIC IDENTIFICATION OF HALOGENATED SURFACTANTS IN BARCELONA'S WATER TREATMENT PLANT,

Instituto de Quimica Bio-Organica, Barcelona (Spain). Lab. d'Espectrometria de Masses.

For primary bibliographic entry see Field 5F.
W89-06790

NMR STUDY OF KRAFT PULP MILL WASTE AND NATURAL HUMIC SUBSTANCES,

Jyvaeskylae Univ. (Finland). Dept. of Chemistry.

Group 5A—Identification Of Pollutants

L. Virkki, J. Knuutinen, P. Mannila, and J. Paasivirta.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 344-346. 2 fig, 3 ref.

Descriptors: *Spectrometers, *Pollutant identification, *Quantitative analysis, *Humic acids, *Pulp wastes, Benzene, Molecular structure, Chemical properties, Kraft mills, Chlorination.

High field proton NMR spectroscopy in DMSO-d6 solution was applied to structural analysis of main high molecular fractions of natural humus and waste lignin from a kraft pulp mill. Main differences appeared in p-disubstituted benzene proton and -CH2 -CO-proton signals, which are absent in the spectrum of waste lignin, obviously due to chlorination. Differences indicate that the common p-substituted aromatic (AA'BB' spectrum) and CH2-neighbor of a carbonyl group in humus have been chlorinated away in kraft lignin waste. A new observation of a 51 Hz 1:1:1 triplet in both spectra is discussed. A possible source for this triplet could be protons of the CONH group, which is common in natural substances and inert against chlorination. Chemical shift of phenyl-CONH-R and the appearance of coupling support the assumption of CONH appearing as triplets of the spectra. (See also W89-06748) (Friedmann-PTT)
W89-06792

IDENTIFICATION OF BIOACCUMULABLE COMPOUNDS IN KRAFT BLEACHING EFFLUENTS,
Senter for Industriforskning, Oslo (Norway).
G. E. Carlberg, H. Drangsholt, N. Gjos, and L. H. Landmark.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 347-352. 2 fig, 1 tab, 11 ref.

Descriptors: *Water pollution sources, *Pollutant identification, *Pulp and paper industry, *Pulp wastes, *Bleaching wastes, *Water analysis, Sampling, Chemical properties, Gas chromatography, Bioaccumulation, Chlorination.

The spent bleach liquor from the chlorination (60% chlorine and 40% chlorine dioxide) and alkaline extraction stages of a bleach plant were analyzed. The mill is a Kraft mill using a spruce and pine mixture. The adsorbable organic halogen of the spent bleach liquors was determined by carbon adsorption, combustion and microcoulometric determination using a Dohrman DX-20 apparatus. The water samples were extracted with cyclohexane at pH 2 and the extractable organic chlorine (EOCl) was determined by neutron activation analysis. The compounds in the cylclohexane extracts were analyzed by a combined gas chromatograph/mass spectrometric system, Finnigan 4021 quadrupole mass spectrometer equipped with a Finnigan 9610 gas chromatograph and an Incos 2300 Data System. Between 0.25 and 1% of the adsorbable organic halogen in the spent bleach liquors bound to potentially bioaccumulable compounds. Chlorinated thiophenes, phenols and terpene derivatives were identified in the lipophilic fraction. (See also W89-06748) (Friedmann-PTT)
W89-06793

CHEMOMETRICS IN ENVIRONMENTAL ANALYTICAL CHEMISTRY,
Rijksinstituut voor de Volksgezondheid en Milieuhygiene, Bilthoven (Netherlands). Lab. for Organic-Analytical Chemistry.
For primary bibliographic entry see Field 2K.
W89-06800

MICROBIOLOGICAL TESTING OF SOILS IRRIGATED WITH EFFLUENTS FROM TERTIARY LAGOONING AND SECONDARY TREATMENT,
Societe du Canal de Provence et d'Amenagement de la Region Provencale le Tholonet, Aix-en-Provence (France). Inst. Mediterraneen de l'Eau.
M. Cadillon, and L. Tremea.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 344-351, 5 tab.

Descriptors: *Soil tests, *Tertiary wastewater treatment, *Wastewater lagoons, *Secondary wastewater treatment, *Wastewater irrigation, *Irrigation effects, *Irrigation, *Water reuse, *Microbiological studies, *Irrigation water, Coliforms, Pathogens, Microorganisms, Incubation, Soil contamination, Lagoons, Wastewater treatment, Secondary wastewater, Water pollution sources, France, Soil bacteria, Water quality.

The results of a microbiological study of soils irrigated with effluents from tertiary lagooning in Porquerolles, France and from secondary treatment in Cogolin, France are summarized. The bacteria under investigation were cultivated on specific media under precise incubation conditions using water and soil samples. The results showed no significant difference between the densities of the indicator bacteria irrigated with wastewater and those in soil irrigated with groundwater. No pathogenic bacteria (staphylococci and salmonellae) were removed from the soil, there was no accumulation of indicator bacteria in the soil from one year to the next, and the type of irrigation had no direct influence on soil contamination. However, the type of irrigation did have an indirect role in the case of secondary effluents where the quantity of water applied influences the total content. (See also W89-06801) (White-Reimer-PTT)
W89-06825

HYDROGEOLOGY AND GROUND-WATER QUALITY OF LANNON-SUSSEX AREA, NORTHEASTERN WAUKESHA COUNTY, WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06864

WATER-DATA PROGRAM OF THE U.S. GEOLOGICAL SURVEY IN KANSAS, FISCAL YEAR 1983,
Geological Survey, Lawrence, KS. Water Resources Div.
For primary bibliographic entry see Field 7A.
W89-06867

ANALYSIS OF AZO DYES IN WATER BY HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY WITH A SWEPT-POTENTIAL ELECTROCHEMICAL DETECTOR,
Georgia Inst. of Tech., Atlanta. School of Chemistry.
P. E. Sturrock.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 202585/AS, Price codes: A03 in paper copy, A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 02-87, March 1987. 17p, 5 fig, 1 tab, 9 ref. USGS contract 14-08-0001-G1219. USGS project G1219-06.

Descriptors: *Pollutant identification, *Water analysis, *Analytical techniques, *Electrochemistry, *Chromatography, *Dye concentrations.

The summarized research investigated the application of a new electrochemical detector to the high-performance liquid chromatographic analysis of water for azo dyes. The detector is a computer-controlled device capable of being programmed to operate in many modes. Rapid-sweep square-wave voltammetry, the preferred mode of operation where applicable, was applied successfully to the azo dyes. For these compounds, the detector is more sensitive than a photometric detector, and the swept mode of operation is useful in resolving components not separated completely by the chromatographic column. (Sturrock-GA Inst. Tech.)
W89-06895

5B. Sources Of Pollution

GROWTH-SUPPORTING ACTIVITY FOR LEGIONELLA PNEUMOPHILA IN TAP WATER CULTURES AND IMPLICATION OF HARTMANNELLID AMOEBAE AS GROWTH FACTORS,
Pittsburgh Univ., PA. Dept. of Pathology.
R. M. Wadowsky, L. J. Butler, M. K. Cook, S. M. Verma, and M. A. Paul.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2677-2682, November 1988. 4 fig, 1 tab, 28 ref.

Descriptors: *Legionella, *Drinking water, *Water pollution sources, *Growth cultures, *Bacteria, *Growth, Cyanophyta, Algae, Heterotrophic bacteria, Pathogenic bacteria, Microbiological studies, Culturing techniques, Filtration, Ecology.

Studies were done with two tap water cultures (WS1 and WS2) containing Legionella pneumophila and associated microbiota to characterize growth-supporting activity and assess the relative importance of the microbiota in supporting multiplication of L. pneumophila. The growth-supporting factor(s) was separated from each culture by filtration and the retentate suspended in sterile tap water. Multiplication of L. pneumophila occurred when both the retentate suspension and the filtrate from either culture were inoculated into sterile tap water. L. pneumophila did not multiply in tap water inoculated with only the filtrate. Growth-supporting activity of the retentate suspension from WS1 was inactivated at 60 C but unaffected at 0, 25, and 45 C after 30-min incubations. Filtration experiments indicated that the growth-supporting factor(s) in WS1 was 2 to 5 microns in diameter. Ciliated protozoa were not detected in either culture. Hartmannellid amoebae were conclusively demonstrated in WS2 but not in WS1. L. pneumophila multiplied in tap water inoculated with the amoebae and the 1-micron filtrate of WS2. No multiplication occurred in tap water inoculated with the filtrate only. Growth-supporting activity for L. pneumophila may be present in plumbing systems; hartmannellid amoebae appear to be important determinants of multiplication of L. pneumophila in some tap water cultures. (Author's abstract)
W89-05792

LONG-TERM SURVIVAL OF HEPATITIS A VIRUS AND POLIOVIRUS TYPE 1 IN MINERAL WATER,
Centre de Recherches du Service de Sante des Armees, Lyon (France). Div. de Microbiologie.
E. Biziagos, J. Passagot, J.-M. Crance, and R. Deloince.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2705-2710, November 1988. 2 fig, 3 tab, 34 ref.

Descriptors: *Mineral water, *Water pollution sources, *Viruses, *Survival, *Human diseases, Culturing techniques, Infection, Temperature, Regression analysis, Microbiological studies, Diseases.

The survival in mineral water of hepatitis A virus (HAV) and poliovirus type 1 was compared, under controlled experimental conditions, at 4 C and room temperature. Viral infectivity titers were determined by cell culture titration, while HAV antigenicity was monitored by radioimmunoassay endpoint titration. Both viruses persisted longest at 4 C. At this temperature, after 1 year of exposure, the inactivation of either HAV or poliovirus type 1 was not important. At room temperature, poliovirus type 1 was not detected after 300 days, whereas HAV was still infectious. For both temperatures, the computed regression coefficients of best-fit lines for inactivation rates for the two viruses were significantly different. The survival of HAV was also studied at 4 C and room temperature in mineral water with 5- and 50-micrograms/ml protein concentrations (i.e., purity of the virus suspension) for 120 days. As shown by comparison of the regression coefficients for the inactivation rates, the stability of HAV in mineral water depends on

protein concentration and temperature. Radioimmunoassay-endpoint titration results showed inactivation patterns similar to those of cell culture titration, with the most significant reduction in HAV antigenicity at room temperature. At the two temperatures, the infectivity of HAV declined at a faster rate than the antigenicity. (Author's abstract)
W89-05793

R PLASMIDS IN ENVIRONMENTAL VIBRIO CHOLERAE NON-O1 STRAINS,
Valencia Univ. (Spain). Dept. of Microbiology.
C. Amaro, R. Aznar, E. Garay, and E. Alcaide.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2771-2776, November 1988. 1 fig, 4 tab, 36 ref. Comision Asesora de Investigacion Cientifica y Tecnica PR83-3166.

Descriptors: *Bacterial analysis, *Bacterial physiology, *Vibrio, *Plasmid transfer, Public health, Chelating agents, Enzymes, Isolation, Physiological ecology, Microbiological studies, Pathogenic bacteria, Aquatic environment.

The occurrence of drug resistance and its plasmid-mediated transferability was investigated in 140 environmental strains of Vibrio cholerae non-O1 and 6 strains of Vibrio cholerae, both O1 and non-O1, of clinical origin. Of the 146 strains tested, 93% were resistant to at least one drug and 74% were resistant to two or more antibiotics. The O1 strains were susceptible to all antibiotics used. A total of 26 of 28 selected resistant wild strains carried R plasmids that were transferable by intraspecific and intergeneric matings. The most common transmissible R factor determined resistance to ampicillin, amoxicillin, and sulfanilamide (30%), followed by resistance to ampicillin and amoxicillin (13%) and resistance to ampicillin, amoxicillin, phosphomycin, and sulfanilamide (9%). Comparison of the three methods of plasmid analysis showed that the method of Birnboim and Doly without EDTA and lysozyme was optimal for isolation of both large and small plasmids in environmental V. cholerae strains. Most strains harbored more than one plasmid, and the molecular sizes ranged from 1.1 to 74.8 megadaltons. The plasmids of high molecular size (around 74 megadaltons) were responsible for the resistance pattern transferred and were maintained with high stability in the hosts. (Author's abstract)
W89-05795

ROLE OF SUBLETHAL INJURY IN DECLINE OF BACTERIAL POPULATIONS IN LAKE WATER,
Cornell Univ., Ithaca, NY. Lab. of Soil Microbiology.
K. R. Gurijala, and M. Alexander.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2859-2861, November 1988. 2 fig, 13 ref. EPA Cooperative Agreement CR812233.

Descriptors: *Sublethal effects, *Fate of pollutants, *Population dynamics, *Bacteria, *Lakes, Water pollution effects, Escherichia coli, Pseudomonas, Klebsiella, Culture media, Survival.

Following their addition to lake water, the populations of Escherichia coli and of antibiotic-resistant strains of Pseudomonas fluorescens, Agrobacterium tumefaciens, Micrococcus flavus, Rhizobium meliloti, and Klebsiella pneumoniae declined rapidly, as determined by counting on media containing antibacterial compounds. The estimates of population sizes were occasionally higher if procedures were used that permitted possible resuscitation of injured cells. No resuscitation procedure yielded consistently higher estimates of populations of surviving cells than the use of selective media alone. The patterns of survival of the test bacteria in lake water amended with eucaryotic inhibitors were essentially the same whether a resuscitation procedure was used or not, and the patterns of survival in sterile lake water or buffer were the same whether counts were made on selective media or on media without antibacterial agents. On the basis of the methods used to show sublethal injury caused by stress, it is suggested that such injury to the test bacteria is not a significant factor involved in their decline in lake water. (Author's abstract)
W89-05800

ROLE OF COMPLEXATION PROCESSES IN CADMIUM MOBILIZATION DURING ESTUARINE MIXING,
Utrecht Rijksuniversiteit (Netherlands). Dept. of Geochemistry.
R. N. J. Comans, and C. P. J. van Dijk.
Nature NATUAS, Vol. 336, No. 6195, p 151-154, November 10, 1988. 3 fig, 1 tab, 24 ref.

Descriptors: *Sorption, *Cadmium, *Mixing, *Estuaries, *Suspended solids, *Path of pollutants, Heavy metals, Trace metals, Particulate matter, Equilibrium, Adsorption, Chemical reactions.

Experiments were conducted to investigate both the reversibility of cadmium sorption on riverine suspended particles in fresh water and the desorption process of pre-adsorbed cadmium in more saline water. In adsorption, an initial period of rapid uptake of cadmium from solution is followed by slow uptake processes that continue over several days. Cadmium was released rapidly from the solids during the early stage of desorption, and continued slowly over the entire reaction period. There is no significant hysteresis between the isotherms of cadmium adsorption and desorption after an equilibration period of 12 days; the distribution of cadmium between the particles and the solution, after adsorption, is restored after desorption under similar conditions. This demonstrates that the sorption process of cadmium on these natural suspended particles is completely reversible. Complexation reactions in solution can completely account for the amount of cadmium released from suspended particles. It is concluded that cadmium is not irreversibly fixed on particles, but can be released in response to changes in the aquatic environment. This may have important implications for the bioavailability of particle-bound cadmium. (Doria-PTT)
W89-05813

RISK ANALYSIS OF AQUIFER CONTAMINATION BY BRINE,
Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
For primary bibliographic entry see Field 2F.
W89-05820

PREDICTION BY THE METHOD OF MOMENTS OF TRANSPORT IN A HETEROGENEOUS FORMATION,
Stanford Univ., CA. Dept. of Civil Engineering.
P. K. Kitanidis.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 453-473, September 30, 1988. 6 fig, 29 ref. NSF Grants ECE-8517598 and ECS 8515 135, Minnesota Water Resources Center Grant USDI 14-08-0001-G1025-02.

Descriptors: *Geohydrology, *Path of pollutants, *Plumes, *Solute transport, *Groundwater movement, Advection, Spatial variation, Mixing, Differential equations, Mathematical analysis, Random processes. Geologic properties.

Natural geologic formations are highly heterogeneous. It is impossible and often unnecessary to describe in deterministic terms the spatial variability of their properties. However, the hydrogeologic properties may be represented in probabilistic terms. Prediction of solute transport may then be defined as the derivation of the probabilistic properties of concentration. The work deals with the first two integral (or spatial) moments of solute concentration in a heterogeneous formation of infinite extent. The first moment is the vector of the mean position of the centroid of the plume and, in a generalized sense, represents advection. The second moment is the matrix of dyadics of the mean squared displacement about the average position of the centroid of the plume and, again in a generalized sense, represents dispersion. Assuming that the mixing at the laboratory scale is Fickian, with random but time-invariant velocities and lab-scale dispersion matrices, the differential equations satisfied by the first two moments are derived. An analytical first-order (or small perturbation) solution was obtained for stationary velocity and compared with a numerical solution. (Author's abstract)
W89-05863

LIFETIME PROBABILITY DENSITY FUNCTION FOR SOLUTE MOVEMENT IN THE SUBSURFACE ZONE,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
G. Sposito, and W. A. Jury.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 503-518, September 30, 1988. 3 fig, 42 ref. NSF Grant ECE-8513726, University of California Water Resources Research Center Grant W-703.

Descriptors: *Statistical analysis, *Path of pollutants, *Probability density function, *Solute transport, *Groundwater movement, *Travel time, Convection-dispersion equation, Mathematical equations, Sand aquifers, Stochastic hydrology.

The conceptual basis and physical significance of the lifetime probability density function (PDF) and its important special case, the travel time PDF, are discussed. The field-scale measurement and use of these two PDFs in characterizing solute mass transfer and solute concentrations in the subsurface zone are described along with their physical interpretation as lifetime or travel time 'spectra.' The relation between the travel time PDF and mechanistic models of subsurface solute transport (e.g., the convection-dispersion equation) is illustrated with an application to three-dimensional reactive solute movement in a sand aquifer. (Author's abstract)
W89-05865

DICHLOROBENZENE IN GROUND WATER: EVIDENCE FOR LONG-TERM PERSISTENCE,
Geological Survey, Lakewood, CO. Water Resources Div.
L. B. Barber.
Ground Water GRWAAR, Vol. 26, No. 6, p 696-702, November-December 1988. 3 fig, 4 tab, 35 ref.

Descriptors: *Benzenes, *Chlorinated hydrocarbons, *Fate of pollutants, *Solute transport, *Path of pollutants, Groundwater pollution, Wastewater disposal, Microbial degradation, Long-term persistence, Groundwater movement, Plumes, Surfactants.

Hydrologic and geochemical evidence were used to establish the long-term persistence of dichlorobenzene in groundwater that has been contaminated from 50 years of rapid-infiltration sewage disposal. An extensive plume of dichlorobenzene extends more than 3,500 m downgradient from the disposal beds, with concentrations of the combined isomers ranging from less than 0.01 to over 1.0 micrograms/L. Based on estimates of maximum groundwater flow velocities, a minimum age of 20 years was established for the farthest downgradient zone of dichlorobenzene contamination. Branched-chained, alkylbenzenesulfonic acid surfactants, which were introduced into the groundwater prior to 1966, occur along with dichlorobenzene in the downgradient part of the plume, further establishing residence of the compounds in the aquifer for at least 20 years. Although dichlorobenzene can be biologically degraded under aerobic conditions, its persistence at this field site is attributed to the dynamics of the groundwater system. Denitrifying conditions, resulting from the degradation of organic compounds in the aquifer near the disposal beds, appear to have enhanced the persistence of dichlorobenzene, which has not degraded by anaerobic bacteria. Biological degradation of dichlorobenzene in the aerobic part of the plume downgradient from the source is probably limited by the paucity of a suitable organic-carbon substrate and the low concentration of dissolved oxygen in the contaminated groundwater. (Author's abstract)
W89-05872

MODIFYING THE USGS SOLUTE TRANSPORT COMPUTER MODEL TO PREDICT HIGH-DENSITY HYDROCARBON MIGRATION,
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
M. A. Hossain, and M. Y. Corapcioglu.
Ground Water GRWAAR, Vol. 26, No. 6, p 717-723, November-December 1988. 2 fig, 3 tab, 10 ref.

Descriptors: *Computer models, *Solute transport, *Model studies, *Path of pollutants, *Groundwater pollution, *Chlorinated hydrocarbons, Soil contamination, Chemical wastes, Accidents, Mathematical models, Waste dumps.

Chlorinated hydrocarbons, such as trichloroethylene (TCE), trichloroethane (TCA), tetrachloroethylene (PCE), chloroform, and carbon tetrachloride, enter soils and groundwater from chemical waste disposal sites and from accidents. The migration of such high-density hydrocarbons in a natural gradient unconfined gravel aquifer was studied. The Buckley-Leverett approach was extended to a 2-dimensional case to simulate a high-density immiscible hydrocarbon displacing groundwater in a gravity-driven system. Previously developed governing equations were solved by modifying the U.S. Geological Survey) solute transport model. The modification incorporates the fractional flow curves of water and their saturation derivatives in vertical and horizontal directions as functions of degree of water saturation. The details of the modification techniques are given, and numerical results are presented for a hydrocarbon spill. The numerical results show that high-density, low-viscosity immiscible chlorinated hydrocarbons can travel deeper and further in contrast to lower-density, higher-viscosity compounds, and that the migration is dominated by gravity, largely uncoupled from the horizontal component, until the plume reaches the lower boundary. (Author's abstract)
W89-05875

ROLE OF INTERCEPTOR DITCHES IN LIMITING THE SPREAD OF CONTAMINANTS IN GROUND WATER,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
For primary bibliographic entry see Field 5G.
W89-05877

BIODEGRADATION OF SURFACTANTS IN SATURATED SUBSURFACE SEDIMENTS: A FIELD STUDY,
Procter and Gamble Co., Cincinnati, OH. Environmental Safety Dept.
T. W. Federle, and G. M. Pastwa.
Ground Water GRWAAR, Vol. 26, No. 6, p 761-770, November-December 1988. 8 fig, tab, 33 ref.

Descriptors: *Fate of pollutants, *Surfactants, *Biodegradation, *Sediments, *Subsurface water, *Saturation zone, Stabilization ponds, Laundromats, Microbial degradation, Wastewater disposal, Bacterial analysis, Mineralization, Adsorption, Linear alkyl sulfonates, Field tests, Ammonium Compounds, Microbiological studies, Biomass, Radiochemistry, Radioactive half-life.

The mineralization of linear alkylbenzene sulfonate (LAS), linear alcohol ethoxylate (LAE), benzylamine, and monoalkyl and dialkyl quarternary ammonium compounds was determined as a function of depth in sediment profiles from beneath a laundromat wastewater pond and pristine control pond. In addition, bacterial number, microbial activity, and concentrations of LAS and quarternary ammonium compounds were measured. Surfactant concentration decreased dramatically with increasing depth in the laundromat profile. Bacterial number and activity decreased with depth in both profiles; however, biomass and activity were higher in the laundromat profile. Mineralization was measured by amending samples with C14-labeled substrates and following the evolution of C14O2 with time. LAS was mineralized without a lag period at all depths in the laundromat profile; its half-life ranged from 3.2 to 16.5 days. In the control pond, it was mineralized more slowly (half-life 5.2 to 1540 days) and only after a lag period of 2 to 40 days. LAE was also mineralized with shorter lags and more rapidly in the laundromat than in the control profile; half-lives ranged between 2.8 to 8.6 days in the former and 3.5 to 137 days in the latter. Although monoalkyl and dialkyl quarternary ammonium compounds were not mineralized in the control profile, slow but significant mineralization of these compounds occurred in the laundromat profile. Benzylamine was rapidly degraded without a lag in both profiles. Field concentration data and the results of mineralization studies indicated that biodegradation combined with the effects of adsorption is a practical mechanism of surfactant removal in subsurface environments. In addition, adaptation resulting from exposure of microbial communities to surfactants is an important factor governing the fate of surfactants in the subsurface. (Author's abstract)
W89-05880

TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA-WATER INTRUSION IN MONTEREY COUNTY, CALIFORNIA.
Monterey County Food Control and Water Conservation District, Salinas, CA.
For primary bibliographic entry see Field 7B.
W89-05881

NUMERICAL MIXING ZONE MODEL FOR WATER QUALITY ASSESSMENT IN NATURAL STREAMS: CONCEPTUAL DEVELOPMENT,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
S. S. Park, and C. G. Uchrin.
Ecological Modelling ECMODT, Vol. 42, No. 3/4, p 233-244, September 1988. 8 fig, 16 ref.

Descriptors: *Model studies, *Path of pollutants, *Fate of pollutants, *Outfall, *Mathematical models, *Wastewater disposal, *Streams, *Mixing, Aquatic life, Numerical analysis, Water quality standards, Advection.

A mixing zone is an area of a water body contiguous to wastewater disposal site in which the water quality does not comply with the water quality standards. The zone has been considered as one of the water quality characteristics for the protection of indigenous aquatic biota and regulated by the in-zone quality and volumetric configuration. The conceptual development of a numerical model which can predict the in-zone quality and volumetric configuration in natural streams is presented. The model is based on the transformed advection-dispersion equation where transverse distance is replaced by dimensionless cumulative discharge. (Author's abstract)
W89-05884

MODELLING LONG TERM STREAM ACIDIFICATION TRENDS IN UPLAND WALES AT PLYNLIMON,
Institute of Hydrology, Wallingford (England).
P. G. Whitehead, B. Reynolds, M. Hornung, C. Neal, and J. Cosby.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 357-368, October-December 1988. 7 fig, 3 tab, 26 ref.

Descriptors: *Model studies, *Mathematical models, *Catchment areas, *Acid streams, *Reforestation, *Acid rain, *Wales, Coniferous forests, Historical trends.

Historical reconstructions and prediction of streamwater acidification are presented for moorland and afforested catchments in the Welsh Uplands at Plynlimon. MAGIC (Model of Acidification of Groundwater in Catchments) is validated by application to an afforested catchment. MAGIC is used to illustrate that atmospheric deposition is primarily responsible for stream acidification but that conifer afforestation can enhance stream acidity. The historical trends determined by the model illustrate that long-term acidification has been present since the turn of the century and will continue unless either deposition levels are reduced significantly or liming is undertaken on a major scale. (Author's abstract)
W89-05890

REVIEW OF CHEMICAL SOLUTE TRANSPORT MODELS,
Technical Univ. of Denmark, Lyngby.
P. Engesgaard, and T. H. Christensen.
Nordic Hydrology NOHYBB, Vol. 19, No. 3, p 183-216, 1988. 5 tab, 94 ref.

Descriptors: *Model studies, *Path of pollutants, *Water chemistry, *Groundwater, *Solute transport, Chemical composition, Reviews, Advection, Dispersion, Equilibrium.

A review of groundwater models capable of simulating solute transport (i.e., advection-dispersion) and equilibrium chemistry processes is presented. Introductory, basic model components are discussed including a physical and a chemical model component and the coupling between the two components. However, emphasis is placed on the chemical model component, since this represents the recent addition to solute transport modeling. Several ways exist of formulating either model component. For the physical model component this may include a continuous description based on the governing mass balance equations or a discontinuous description by a mixing cell approach. For the chemical model component, i.e. processes such as ion exchange, adsorption, complexation, precipitation/dissolution and open/closed carbonate system reactions, local equilibrium is usually assumed. The assumption of local equilibrium is investigated. The relation between the continuous formulation and a coupling/decoupling of the physical and chemical components and the resulting nature of the mathematical problem and its numerical strategy is briefly discussed. In all, 27 models have been surveyed in terms of their physical and chemical model components, their verification and applicability to field scale problems. Due to a lack of actual field application it has not been possible to evaluate all models in natural settings and thus, each model will, in theory, be valid when the constraints given by the assumptions and limitations taken in developing the model are met. The models show great diversity with respect to complexity and general applicability to field scale problems. Most of the models were developed for specific purposes and it is difficult to point out one or more general models. However, there exist many ways of formulating a model both with respect to transport and chemical calculations, but also to numerical techniques. Many of the models are very complex and future research should be directed towards validation studies of these models on a field scale rather than developing still more complex models. (Author's Abstract)
W89-05902

LESSONS FROM THE DISPERSION AND DEPOSITION OF DEBRIS FROM CHERNOBYL,
Meteorological Office, Bracknell (England).
F. B. Smith.
Meteorological Magazine MTMGA5, Vol. 117, No. 1395, p 310-317, October 1988. 5 fig, 3 ref.

Descriptors: *Disasters, *Radioactive wastes, *Chernobyl, *Atmospheric transport, *Path of pollutants, *Nuclear powerplants, Plumes, Rainfall, Deposition, Dispersion, Wind, Agriculture, Soil, Pollutants, Contamination, Fallout, Population exposure, Model studies, Grazing, Soil types.

A number of lessons of meteorological interest have been learned from the Chernobyl nuclear accident. The plume behaved much like a conventional plume from a factory chimney, growing under the action of three-dimensional turbulence in a quasi-conical manner. Changes of wind speed and direction with height through the plume were principal factors in diluting the concentration within the plume. Dilution occurs when shear is coupled with vertical mixing, either concurrently or successively through a diurnal cycle. Although most trajectory analyses carried out on the release have been reasonably successful in predicting the

spread of debris over Europe, it is almost certain that individual trajectories starting from Chernobyl at the same time differed significantly at long range and the apparent overall success simply reflects the variable meteorological situation during the whole release. With respect to deposition, it was found that large releases will usually be hot releases and much of the airborne debris will rise away from the surface. How far it rises will depend critically on the stability of the air, and this will have consequences for the subsequent transport and deposition of the material. Washout rates and dry deposition velocities will differ significantly from one species to another, and these need to be well known in advance of any accident if model output is to be of real value. Rainfall and deposition from the thunderstorms during the passage of the debris over the U.K. were banded in narrow elongated 'footprints'. Interpolation between measurements of Cs137, for example, on grass or soil should therefore be carried out with strong along-wind weighting and not with simple circular weighting. The Chernobyl accident has emphasized how much more efficient wet deposition is compared with dry deposition whenever rain occurs. Agriculturists wishing to monitor levels of deposition rapidly should concentrate initially on areas where significant rain intercepted the debris. In areas where little or no rain occurred most of the deposition was through dry deposition and a high percentage was retained on the vegetation available to grazing animals. It was also found that soil type can critically influence the duration of the continued contamination of foodstuffs and grazing animals. (Sand-PTT)
W89-05907

POTENTIAL CONTAMINANT MOVEMENT THROUGH SOIL JOINTS,
Soil Conservation Service, Washington, DC.
L. Kirkaldie.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 25, No 4, p 520-524, November 1988. 7 fig, 9 ref.

Descriptors: *Path of pollutants, *Soil joints, *Soil physical properties, *Fracture permeability, *Soil water movement, Lacustrine soils, Tectonics, Aeration zone, Glacial soils, Model studies, Solute transport, Loess, Alluvial soils, Soil genesis.

Joints in soils can have many causes. In glacial tills causes for joints include stresses from overriding ice, stress release, desiccation and rebound. They may also be propagated from fracture traces in the underlying rock. In loess, alluvium, and lacustrine materials, many of the joints appear to be propagated upward indicating a tectonic relationship. Joints in some lacustrine and alluvial deposits have been attributed to desiccation and stress release. Further investigations will probably show that many soil joints are tectonically related and that joints in many terrestrially deposited sedimentary rocks predate induration. Soil joints are common in nonindurated materials. In most cases soil joints can be measured and defined and should be used in developing new models for water movement in the unsaturated zone. These models could improve our understanding of the movement of nutrients, pesticides, and agricultural waste through the unsaturated zone into the groundwater. (Author's abstract)
W89-05913

HYDROLOGICAL AND CHEMICAL INPUTS TO FIR TREES FROM RAIN AND CLOUDS DURING A 1-MONTH STUDY AT CLINGMANS PEAK, NC,
General Motors Research Labs., Warren, MI. Environmental Science Dept.
J. M. Dasch.
Atmospheric Environment ATENBP, Vol. 22, No. 10, p 2255-2262, October 1988. 2 fig, 5 tab, 28 ref.

Descriptors: *Chemistry of Precipitation, *Alpine regions, *Fir trees, *Rain, *Clouds, *Acid rain, *North Carolina, Hydrogen ion concentration, Calcium, Magnesium, Potassium, Sulfates, Ammonium, Nitrates, Interception, Canopy, Throughfall.

Wet deposition inputs were measured at Clingmans Peak, NC, during August-September of 1986. Rain, cloud water and throughfall were collected in an attempt to determine total wet inputs to this high elevation spruce-fir ecosystem. Previous reports have suggested that cloud interception provides as much moisture to the canopy as rain. In this study the cloud interception rate was determined based on the throughfall volume collected beneath the trees, after accounting for losses in the canopy. The cloud interception rate in the canopy was only 0.5 mm water/day compared to a rainfall rate of 6.8 mm water/day. The pH of cloud water ranged from 3.1 to 5.1 compared to a range of 4.1-5.2 for rain water. Other species were 6-33 times more concentrated in clouds than rain water. Throughfall had higher levels of Ca(2+), Mg(2+), K(+), and SO4(--) than the sum of clouds and rain inputs, but lower levels of NH4(+) and NO3(-), indicating N uptake by the canopy. It has been suggested that the trees on Clingmans Peak are receiving large doses of pollutants due to heavy rainfall, high cloud interception and high ion concentrations in the clouds. However, wet inputs to the canopy during this study were comparable to those measured at low elevation sites throughout the northeastern U.S. In contrast, a single exposed tree on the summit intercepted 10 times more cloud water and received 6 times higher wet deposits from rain and clouds than trees in the canopy. It is unclear whether the atmospheric loadings received by exposed trees, such as trees standing alone, trees on the edge of the canopy, or trees on the summit, are sufficient to result in forest decline. (Author's abstract)
W89-05915

ASSESSMENT OF THE RELATIONSHIP BETWEEN FUNCTIONAL GROUPS OF WEATHER ELEMENTS AND ATMOSPHERIC POLLUTION IN CALGARY, CANADA,
Calgary Univ. (Alberta). Dept. of Geography.
L. C. Nkemdirim.
Atmospheric Environment ATENBP, Vol. 22, No. 10, p 2287-2296, October 1988. 4 fig, 13 tab, 25 ref.

Descriptors: *Chinook, *Canada, *Path of pollutants, *Air pollution, *Weather patterns, Ventilation, Energy, Wet deposition, Calgary.

Nine regularly observed meteorological elements were classified into 4 functional groups - ventilation, energy, wet deposition and Chinook - and the contribution of each group to the air pollution process in Calgary assessed by multiple correlation. While ventilation was the dominant process in most situations, the energy terms were the most significant during a smog. Heavy air pollution often occurred during a Chinook if the wind was weaker than 3 m/s. A linear combination of weather elements successfully separated clean from polluted air except on weekends and very cold weather. (Author's abstract)
W89-05916

SEASONAL TRENDS OF ALUMINUM CHEMISTRY IN A SECOND-ORDER MASSACHUSETTS STREAM,
Syracuse Univ., NY. Dept. of Civil Engineering.
D. C. McAvoy.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 528-534, October-December 1988. 6 fig, 1 tab, 34 ref. Massachusetts Division of Water Pollution Control, Project No. 83-86-B.

Descriptors: *Acid rain effects, *Streams, *Aluminum, *Chemical properties, *Fish, *Toxicity, Seasonal variation, Spatial variation, Mountains, Wetlands, Organic acids, Solubility, Path of pollutants, Chemical reactions.

An investigation of streamwater chemistry was conducted to evaluate seasonal and spatial variations of Al in an acid-sensitive watershed. Monthly grab samples were collected from 3 stream sites along the West Wachusett Brook, Massachusetts, and analyzed for all major solutes from March 1985 to January 1986. Total monomeric Al concentrations were greatest during high runoff periods with values as high as 22 and 11 micromolar in upland and wetland runoff, respectively. Survey results also illustrated the importance of ionic solute concentrations to the mobility and transport of Al. The mountain stream showed that basic cation dilution was an important factor contributing to greater Al transport during high flow periods. In contrast, organic acids in the wetland stream served as a mobile anion, and thus greatly affected Al transport by complexation and charge balance effects. Solubility with an aluminum hydroxide mineral phase did not appear to be a controlling factor of streamwater Al concentrations throughout the year. Results from a chemical equilibrium model showed the mountain stream to be potentially toxic to fish during high-flow periods, whereas the wetland stream, being dominated by organo-Al complexes, had a minimal potential for toxicological effects. (Author's abstract)
W89-05926

ALUMINUM AND IRON EQUILIBRIA IN SOIL SOLUTIONS AND SURFACE WATERS OF ACID MINE WATERSHEDS,
Kentucky Agricultural Experiment Station, Lexington. Dept. of Agronomy.
A. D. Karathanasis, V. P. Evangelou, and Y. L. Thompson.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 534-543, October-December 1988. 5 fig, 9 tab, 27 ref.

Descriptors: *Path of pollutants, *Acid mine drainage, *Water pollution sources, *Strip mines, *Aluminum, *Iron, Soil, Surface water, Groundwater, Chemical properties, Kaolinite, Gibbsite, Jurbanite, Alunite, Jarosite, Hydrogen ion concentration, Sulfates, Solubility, X-ray diffraction, Heavy metals, Watersheds, Minerals.

The composition of soil solutions and surface waters emanating from unreclaimed or partially reclaimed stripmined watersheds with low buffering capacity in Kentucky were compared with soil solution compositions of unaffected strata in the watershed. The data suggest that almost 20 yr after mining, most soil solutions and surface waters of the disturbed areas still contain high levels of dissolved Al, controlled primarily by the solubilities of a jurbanite-like mineral (upper limit) and alunite (lower limit). Soluble Al in solutions of undisturbed areas was consistent with the solubility of kaolinite or gibbsite. The absence of jurbanite x-ray diffraction peaks suggested the presence of an amorphous or a mineral stoichiometrically similar to jurbanite. Despite greater contact times of soil solutions with the soil compared to surface waters, their compositional differences were insignificant. The control of soluble Al by basic aluminum sulfate minerals was not affected by the variable mineralogical and textural composition of soil and geologic strata in the watershed. Apparently, this is the result of low buffering capacity. At pH <4, pH and sulfate activities can be used to accurately predict the levels of soluble Al(3+) in surface and groundwaters of the watersheds. Similar predictions from pH and SO4(--) activities can also be made for dissolved Fe(3+) levels, supporting the stoichiometry but a much higher solubility than that of jarosite. (Author's abstract)
W89-05927

RELATIVE CONCENTRATIONS OF CADMIUM AND ZINC IN TISSUE OF SELECTED FOOD PLANTS GROWN ON SLUDGE-TREATED SOILS,
Won Kwang Univ., Iri (Republic of Korea). Dept. of Agricultural Chemistry.
For primary bibliographic entry see Field 5E.
W89-05928

SELENATE TRANSPORT IN STEADY-STATE, WATER-SATURATED SOIL COLUMNS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. H. Alemi, D. A. Goldhamer, and D. R. Nielsen.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 608-613, October-December 1988. 7 fig, 2 tab, 20 ref.

Descriptors: *Selenium, *Selenates, *California, *Kesterson National Wildlife Refuge, *Soil water,

*Pore water, *Path of pollutants, Loam, Soil columns, Radioactive tracers, Heavy metals, Sulfates, Leaching, Adsorption, Diffusion coefficient.

Transport of selenate in steady-state, water-saturated soil columns was evaluated under different pore water velocities, ionic compositions, and two soil bulk densities. The soil was Panoche loam (Typic Torriorthents) saturated with 0.005 M CaSO4, 0.005 M CaCl2, or 0.05 M CaCl2. To examine the movement of selenate in soil relative to water and SO4(--) (a biogeochemically similar anion), breakthrough curves of Se75-SeO4(--), along with H3-(H2O) or S35-SO4(--), were observed. Selenate appeared before elution of one pore volume and always ahead of the H2O and SO4(--) except in 0.05 M CaCl2, indicating exclusion of selenate by the soil matrix. On the other hand, soil analysis of selenate following the leaching indicated that selenate was retained by the soil, suggesting simultaneous exclusion and adsorption of selenate. Increasing pore water velocity and soil bulk density did not shift the position of the breakthrough curves significantly. Assuming equilibrium linear adsorption-desorption of selenate by soil, the values of the apparent diffusion coefficient (D) and retardation factor (R) were obtained by fitting the solution of the solute transport equation without sink and source terms to the measured breakthrough curves of selenate. The values of D showed an increasing trend with pore water velocity and the values of R were influenced by ionic composition of the soil solution. (See also W89-05933) (Author's abstract)
W89-05932

ELUTION OF SELENIUM FROM CONTAMINATED EVAPORATION POND SEDIMENTS,
California Univ., Davis. Dept. of Land, Air and Water Resources.
M. H. Alemi, D. A. Goldhamer, M. E. Grismer, and D. R. Nielsen.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 613-618, October-December 1988. 4 fig, 7 tab, 12 ref.

Descriptors: *Kesterson National Wildlife Refuge, *California, *Selenium, *Ponds, *Sediments, *Path of pollutants, *Soil water, Microorganisms, Leaching, Fluorometry, Heavy metals, Biotransformation.

Se-contaminated sediments were collected from evaporation ponds at the Kesterson National Wildlife Refuse in California. Columns of undisturbed, freeze-dried, and air-dried sediments were each leached with deionized water, California aqueduct water, and saline water. Total Se and inorganic Se were measured in the effluent. Following leaching, the sediment cores were sectioned, extracts were prepared using deionized water, and analyzed for total Se, inorganic Se, and selenite using fluorimetric techniques. Se remained immobile in the undisturbed sediments, but freeze-drying and air-drying increased Se mobility. The maximum concentrations of total Se in the effluent from undisturbed, freeze-dried, and air-dried sediments were 32, 7600, and 232,650 nmol/L, respectively. Microbial activity played an important role in the reduction of Se to immobile and volatile forms. Se recovered in the effluent and from water extraction of the sediments following leaching was highest for deionized water and least for aqueduct water under nonsterilized conditions. The composition of solution did not significantly influence the leaching of Se under sterilized conditions. Introducing Se to previously leached sediments resulted in an increase in water-extractable Se, particularly near the surface. However, when the concentration of added Se was high (31.70 micromol/L), the increase in water-extractable Se also occurred at greater depths in the sediments. (See also W89-05932) (Author's abstract)
W89-05933

MIGRATION OF TECHNETIUM, IODINE, NEPTUNIUM, AND URANIUM IN THE PEAT OF TWO MINEROTROPHIC MIRES,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Environmental Research Branch.
M. I. Sheppard, and D. H. Thibault.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 644-653, October-December 1988. 7 fig, 4 tab, 17 ref.

Descriptors: *Wetlands, *Path of pollutants, *Radioactive wastes, *Mires, *Peat, *Groundwater pollution, *Technetium, *Iodine, *Neptunium, *Uranium, *Hazardous wastes, Migration, Hydrogen ion concentration, Sodium, Magnesium, Calcium, Sulfates.

Mires may become receptors of hazardous wastes transported by the groundwater from surface or underground disposal facilities. Should the contributing water sources contain dissolved solutes, they may sorb onto the organic matter in the mire, precipitate out of solution, or form more or less mobile complexes or colloids. This study investigated the vertical migration of Tc, I, Np, and U in two types of mires typical of the Precambrian Shield. Seasonal groundwater level fluctuations and chemical composition changes in the mires are also reported. The results indicate dramatic seasonal changes in the pH and chemical composition of the groundwater, particularly the concentrations of Na, Mg, Ca, and SO4. Iodine, in spite of being sorbed to the peat with a sorption coefficient, Kd, of 0.2 to 64 L/kg, migrated quickly through the peat in the porewater. The aeration status and the botanical origin of the peat seem to be factors in the retardation of I. Iodine accumulated on the mire surface in late summer when the water table was lower. However, Tc, U, and Np were quickly immobilized in the reducing environment of the mire and did not migrate very far from their entry point. Geometric mean Kd values for U in the three peats varied from 2600 to 19,000 L/kg. The Kd values for U did not depend on porewater concentration, humidification, or aeration. A comparison between Kd values for U obtained in situ and in laboratory studies showed that the incubation-sorption system may be a satisfactory technique for U. Neptunium Kd values varied from 31 to 2600 L/kg and Tc Kd values were > 2 L/kg in these three peats. The Kd values are general indicators of the mobility of these elements in mires, the most mobile being I followed by Tc, Np, and U. (Author's abstract)
W89-05936

CASE STUDY OF THE EFFECTS OF OIL SHALE OPERATIONS ON SURFACE AND GROUNDWATER QUALITY: I. SOURCES OF CONTAMINATION AND HYDROLOGIC CONTROLS ON WATER COMPOSITION,
Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
T. R. Garland, R. E. Wildung, and J. M. Zachara.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 653-659, October-December 1988. 9 fig, 13 ref. Office of Health and Environmental Research, Department of Energy, Contract DE-AC06-76RL0 1830.

Descriptors: *Oil shale, *Groundwater pollution, *Oil shale wastes, *Surface water, *Saline water intrusion, *Water quality, *Contamination, *Path of pollutants, Wells, Seeps, Leaching, Evaporation ponds, Subsoil, Artificial recharge, Snowmelt, Transpiration, Seasonal variation, Colorado.

A study was undertaken to determine the effects of the disposal and leaching of retorted shale and other wastes on the water quality of a local drainage at the Rifle Oil Shale Project. An estimated 200,000 t of retorted shale and 146,000 t of raw shale were disposed during a 35-yr period at the site, located near Anvil Points, CO. Previous studies suggested that operations did not impact the site. However, this investigation revealed elevated salt concentrations in wells, seeps, and surface waters downstream of the site. This investigation included a detailed survey of the potential contaminant and water sources at the site and measurement of inorganic and organic constituents in surface and groundwaters as a function of proximity to the disposal areas and hydrologic factors in the watershed. Sources of the salts were unlined evaporation ponds, subsoils leached by waters from leaking sanitary water system, and leachates from the raw and retorted shale piles, which also serve as artificial water recharge areas. These sources had not been previously detected because prior investigations did not take into account distinct spatial and diurnal fluctuations in flow rate in the surface waters, which alternately diluted and concentrated contaminants contributed by groundwater recharge. Fluctuations in flow rate were shown to result from daily meteorological effects on snowmelt (December-March) and transpiration by vegetation in the watershed (June-December). Detailed assessments of these factors are required before the long-term effects of an oil shale industry on the Colorado River Basin can be determined. (See also W89-05938) (Author's abstract)
W89-05937

CASE STUDY OF THE EFFECTS OF OIL SHALE OPERATIONS ON SURFACE AND GROUNDWATER QUALITY: II. MAJOR INORGANIC IONS,
Battelle Pacific Northwest Labs., Richland, WA. Environmental Sciences Dept.
T. R. Garland, J. M. Zachara, and R. E. Wildung.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 660-666, October-December 1988. 4 fig, 2 tab, 23 ref. Office of Health and Environmental Research, Department of Energy, Contract DE-AC06-76RL0 1830.

Descriptors: *Oil shale, *Groundwater pollution, *Oil shale wastes, *Surface water, *Water quality, *Contamination, *Path of pollutants, *Ions, Sodium, Magnesium, Calcium, Sulfates, Bicarbonates, Nitrification, Chloride, Lithium, Leachates, Colorado, Seasonal variation.

The distribution of the major inorganic ions in surface and groundwater, as related to substrata and hydrologic phenomena, was determined in a semiarid watershed representing an important area of oil shale development in northwestern Colorado. Surface and alluvial groundwaters were analyzed with time over a period of 1 yr, both upstream and downstream of an unengineered oil shale disposal site. These observations provided unique insight into the chemical and hydrologic controls on the composition of major ions in ground and surface waters. The primary dissolved species above and below the disposal site were Na(+), Mg(2+), Ca(2+), SO4(--), and HCO3(-). Increases in total salts in alluvial groundwaters below the disposal site were due primarily to Na(+) and SO4(--). Groundwaters above the disposal site were found to be in near equilibrium with calcite and dolomite; waters below the site were also in equilibrium with gypsum. Concentrations of the other ions measured all increased below the site, but elements lacking major solubility controls in calcareous soil and subsoil, i.e., K(+), Li(+), Cl(-), and NO3(-), were most elevated. These solutes decreased in concentration down-gradient from the waste disposal area, but different phenomena controlled their behavior. Concentrations of HCO3(-) in alluvial groundwater fluctuated seasonally (+20%), reflecting a combination of biological (microbial and root respiration) and mineral solubility (e.g. CaCO3) controls. Although the primary source of N to groundwater was NH4-laden waste water, NO3 constituted the major N species measured as a result of nitrification in the relatively aerobic groundwater system. Macroions indicative of the influence of the waste disposal site on surface water quality were Cl(-), K(+), and Li(+). Lithium could serve as a sensitive indicator of the presence of retorted shale leachate. (See also W89-05937) (Author's abstract)
W89-05938

STREAMFLOW NUTRIENT DYNAMICS ON COASTAL PLAIN WATERSHEDS,
Agricultural Research Service, Tifton, GA. Southeast Watershed Research Center.
R. Lowrance, and R. A. Leonard.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 734-740, October-December 1988. 1 fig, 7 tab, 18 ref.

Descriptors: *Nonpoint pollution sources, *Water pollution sources, *Path of pollutants, *Georgia, *Coastal plains, *Nutrient dynamics, Nitrates, Ammonium, Chlorides, Orthophosphates, Phosphorus, Nitrogen, Conductivity, Agriculture, Little River, Watersheds, Streamflow.

Streamflow and water quality parameters were measured on five watersheds (262 ha-11,487 ha) of the Little River in the coastal plain near Tifton, Georgia. Concentrations of nitrate, ammonium, chloride, orthophosphate, total P, total N, and electrical conductivity were determined. Loads and flow-weighted concentrations were calculated for the five watersheds and for six watersheds formed by subtraction of smaller watersheds from larger ones. Mean concentrations and total loads calculated from samples taken every 3 h were not significantly different from samples taken every 12 h on two watersheds. In general, nitrate was enriched and chloride diluted relative to baseflow during storm events. This was attributed to reduction of nitrate in soils and aquifers of riparian areas. Both nitrate loads and concentrations were decreased during low flow years, whereas chloride was significantly higher in a year with abnormally low flows. Orthophosphate increased during storm events, but total P showed the opposite response. Enrichment of nitrate-N and orthophosphate and dilution of chloride and conductivity were due, in part, to concentrations in rainfall. Nutrient loads on the 11 watersheds and subwatersheds were similar except for one watershed that had the lowest percent of cropland but the highest loads. These high loads were due to exceptionally high flow rates in 1983 and 1984 following clear cutting of forest on nearly 25% of the subwatershed in late 1982. Nutrient loads in streamflow were not correlated with the percent of land in spring-planted row crops but were correlated with land in winter wheat, which is fertilized in late fall or early winter. Conditions that change hydrologic responses of watersheds may change the nonpoint sources of nutrients by changing water volumes and by altering processes that create nutrient concentrations in streamflow. (Author's abstract)
W89-05942

MODIFIED PURGE-AND-TRAP/GAS CHROMATOGRAPHY METHOD FOR ANALYSIS OF VOLATILE HALOCARBONS IN MICROBIOLOGICAL DEGRADATION STUDIES,
Northrop Services, Inc., Ada, OK.
For primary bibliographic entry see Field 5A.
W89-05943

PERSISTENCE OF HEXAZINONE (VELPAR), TRICLOPYR (GARLON), AND 2,4-D IN A NORTHERN ONTARIO AQUATIC ENVIRONMENT,
Canadian Centre for Toxicology, Guelph (Ontario).
K. R. Solomon, C. S. Bowhey, K. Liber, and G. R. Stephenson.
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 36, No. 6, p 1314-1318, November/December 1988. 5 fig, 3 tab, 11 ref.

Descriptors: *Herbicides, *Aquatic environment, *Path of pollutants, *Ontario, *Lakes, *Fate of pollutants, *Water pollution, Adsorption, Bogs, Sand, Triclopyr, Hexazinone, Mesocosms, Water samples, Sediments, Oxygen, Temperature.

A field study was conducted in enclosures located in a typical bog lake in a sandy soil near Matheson in northeastern Ontario. Three groups of polyethylene enclosures each were constructed and installed in the lake. Three enclosures each were treated with triclopyr (butoxyethanol ester), with 2,4-D (isooctyl ester), and hexazinone (solution) at rates equivalent to 0.3 and 3.0; 1.0 and 2.5; and 0.4 and 4.0 kg/ha, respectively. Water, sediment, and enclosure wall samples were analyzed for residues, and temperature and oxygen levels were measured. A significant dose-dependent change in oxygen concentration was only seen in the hexazinone-treated enclosures. Rates of dissipation of 2,4-D were similar at both concentrations, and within 15 days less than 5% remained in the water. Up to 25% of the 2,4-D adsorbed to the sides of the corrals. Triclopyr concentration in water was below 5% from day 15 and could not be detected from day 42 onward. The amount of pesticide adsorbed to the sides of the enclosures was lower and appeared to dissipate more rapidly than was the case with 2,4-D. At the lower application rate, hexazinone was undetectable 21 days and at the higher rate 42 days after application. Hexazinone dissipated more rapidly than 2,4-D and was not adsorbed to sediments. (Author's abstract)
W89-05948

DEGRADATION OF FLUAZIFOP-BUTYL IN SOIL AND AQUEOUS SYSTEMS,
Turin Univ. (Italy). Ist. di Chimica Agraria.
M. Negre, M. Gennari, A. Cignetti, and E. Zanini.
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 36, No. 6, p 1319-1322, November/December 1988. 2 fig, 1 tab, 23 ref. Regione Piemonte Assessorato Sanita Grants 115-116, and Consoglio Mazionale Delle Ricerche Grant 86.00840.06.

Descriptors: *Halogenated pesticides, *Soil water, *Degradation, *Soil contamination, *Fate of pollutants, *Herbicides, Fluazifop-butyl, Hydrolysis, Water pollution, Pesticide kinetics, Soil bacteria, Water pollution.

The degradation of fluazifop-butyl was studied in sterile buffered water, in sterile soil, and in nonsterile soil with different moisture contents. Fluazifop-butyl was stable in sterile buffered water at pH 4 and 7, with more than 90% of the initial amount remaining in solution after 21 days. At pH 9, fluazifop-butyl degraded following a pseudo-first-order kinetics with a half-life of 2.5 days. Fluazifop-butyl was used at a concentration of 10 mg per kg soil in studies of soil degradation. In air-dried soil, 40% of the applied fluazifop-butyl remained in the soil 21 days after treatment. However, with a higher soil moisture content, less than 5% of the applied fluazifop-butyl was present after 7 days. There was a slower dissipation rate in sterile soil than in non-sterile soil, indicating that microflora play a role in fluazifop-butyl degradation. The degradation of fluazifop-butyl in soil and water proceeded mainly by hydrolysis, with fluazifop as the major product. (Author's abstract)
W89-05949

WEATHER INPUT FOR NONPOINT-SOURCE POLLUTION MODELS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
N. B. Pickering, J. R. Stedinger, and D. A. Haith.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 674-690, November 1988. 6 tab, 74 ref.

Descriptors: *Meteorology, *Path of pollutants, *Model studies, *Weather, *Simulation, *Nonpoint pollution sources, *Stochastic models, Weather data collections, Temperature, Precipitation, Model testing, Frequency distribution, Comparison studies, Runoff, Percolation, Nutrients.

Three stochastic weather models are developed for use with nonpoint-source pollution simulation models that require sequences of daily precipitation and mean daily temperature. Two simple models have parameters that can be estimated from available secondary data. Both generate temperature and precipitation independently. A third model represents a more sophisticated approach and requires primary data for parameter estimation. A model validation analysis was attempted using three U.S. weather stations. The first two models did not reproduce the higher-order moments or the tail of the wet-dry precipitation distribution. All models used normal temperature distributions which did not reproduce the higher-order moments of the observed temperature distributions. Using historical and generated weather data as input to the Cornell Nutrient Simulation model, annual runoff and percolation, and dissolved nitrogen and phosphorus losses were compared. The third model gave output that was not statistically different from that obtained with the historical weather data; the first two models occasionally gave statistically different values. Using the mean annual losses given by historical weather data as a basis, model errors were less than 20%. (Author's abstract)
W89-05963

PHENANTHRENE DEGRADATION BY ESTUARINE SURFACE MICROLAYER AND BULK WATER MICROBIAL POPULATIONS,
New Hampshire Univ., Durham. Dept. of Microbiology.
W. F. Guerin.
Microbial Ecology MCBEBU, Vol. 17, No. 1, p 89-104, January/February 1989. 5 fig, 4 tab, 56 ref. NOAA Grant NA-81-AA-D-0035.

Descriptors: *Fate of pollutants, *Estuarine environment, *Bacteria, *Surface water, *Water pollution effects, *Biodegradation, *Microbial degradation, Phenanthrene, Microlayer, Degradation, Aromatic compounds, New Hampshire, Nitrogen, Phosphorus, Spectrophotometry, Fluorometry.

Paired surface microlayer and bulk water samples from five sites in the Great Bay Estuary, New Hampshire, were examined with regard to numbers of bacteria, 14C-phenanthrene biodegradation potentials, and organic and inorganic chemical characteristics. Microlayer samples were generally enriched in nutrients (N and P), dissolved organic matter, and culturable heterotrophic bacteria compared with their corresponding bulk waters. Microlayer samples from marine environments were also enriched in aromatic hydrocarbons, as determined by UV spectrophotometric and fluorometric analyses, and demonstrated substantial phenanthrene biodegradation activity in the assay employed. Biodegradation activity of marina bulk water samples ranged from nil to levels exceeding those exhibited by microlayer samples. No diminution of biodegradation activity was observed after filtration of microlayer water, indicating that the responsible organisms were not particle-associated. Phenanthrene-degrading bacteria, enumerated by counting clearing zones in a crystalline phenanthrene overlay after colony development on a phenanthrene/toluene agar medium, were superior to epifluorescence direct counts or standard plate counts on phenanthrene/ toluene agar medium or estuarine nutrient agar in predicting 14C-phenanthrene biodegradative activity. (Author's abstract)
W89-05968

INFLUENCE OF SIMULATED RAINFALL ON THE TRANSPORT AND SURVIVAL OF SELECTED INDICATOR ORGANISMS IN SLUDGE-AMENDED SOILS,
Engineering Science, Fairfax, VA.
J. Zyman, and C. A. Sorber.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2105-2110, December 1988. 4 fig, 6 tab, 9 ref.

Descriptors: *Sludge disposal, *Soil amendments, *Path of pollutants, *Wastewater treatment, *Sludge, *Soil, *Coliforms, *Leachates, Simulated rainfall, Rainfall impact, Fecal coliforms, Total coliforms, Decay, Bioindicators, Sludge utilization.

Indicator organism transport and survival was evaluated using cylinders containing a soil and sludge mixture exposed to different rainfall rates. Concentrations of fecal and total coliforms at different depths and in the leachate at different times were observed. Overall, indicator organism concentrations decreased with time. Total coliforms had an average T90 (90% reduction) of 9 days while fecal coliforms showed a T90 of 6 days. Decay rates were apparently independent of rainfall rates. Decay rates of 0.25 per day for total coliforms and 0.35 per day for fecal coliforms were observed. Lack of moisture promoted die-off. Under these conditions, decay rates were 0.44 per day for total coliforms and 0.56 per day for fecal coliforms. Leachate concentration organisms never exceeded 2.1% of the total coliforms and 1.4% of the fecal coliforms originally present in the sludge soil mixture. (Author's abstract)
W89-05975

EXCHANGE PROCESSES IN ESTUARIES SUCH AS THE WESTERSCHELDE: AN OVERVIEW.
Nederlands Inst. voor Onderzoek der Zee, Texel.
E. K. Duursma, A. G. A. Merks, and J. Nieuwenhuize.

Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 7-20, 1988. 10 fig, 3 tab, 19 ref.

Descriptors: *Path of pollutants, The Netherlands, *Westerschelde, *Estuaries, *Rivers, *Polychlorinated biphenyls, *Metals, *Fate of pollutants, Exchange processes, Partitioning, Residence time, Saline-freshwater interfaces.

A short overview is presented on the principles of exchange processes of metals and polychlorinated biphenyls for the Westerschelde, the estuary between the river Schelde and the North Sea. Critical reference is made to the commonly used interpretation of concentration-salinity mixing curves of dissolved material, and to the application of stability and distribution constants for metal species partitioning between dissolved, complexed and solid phases. In particular, the partitioning issues discussed include: (1) partitioning between dissolved inorganic and organic metals, (2) partitioning of substances between water and particulate matter, and (3) partitioning effected by the bottom. Essentially, the partition and exchange processes of polychlorinated byphenyls, PCBs, are not different from those of metals, and are based on partitioning between water and particulate matter (seston), or water and fat in aquatic organisms (mammals excluded). For the Westerschelde the results clearly demonstrated that relatively constant Kds were determined for these two kinds of PCB partitioning, despite the high concentrations of PCVs in freshwater and low concentratios in seawater. The Schelde River and Westerschelde Estuary may be better understood, if the available knowledge on partitioning of contaminants and their residence or adaptation times were applied in hydrodynamical and geochemical models. This application would be of particular importance for the underwater bottom with respect to its uploading with metals an organic contaminants. (Miller-PTT)
W89-05981

HISTORICAL AND RECENT DATA OF THE WATER CHEMISTRY AND PHYTOPLANKTON IN THE RIJNLAND AREA,
Hoogheemraadschap van Rijnland, Leiden (Netherlands).
A. P. Klapwijk.
Hydrobiological Bulletin HYBUD9, Vol. 22, No. 1, p 93-94, 1988. 1 tab, 4 ref.

Descriptors: *Water pollution sources, *Water chemistry, *Lakes, *Phytoplankton, *Nutrients, *Limiting nutrients, *Nitrogen, *Phosphorus, Biological oxygen demand, Chlorophyll a, Seston, The Netherlands.

A comparison has been made between 1941/42 and recent data on water chemistry and phytoplankton in two canals and two lakes in the western part of The Netherlands. Especially orthophosphate, but also inorganic nitrogen, has increase tremendously especially in the Gouwe Canal where Rhine water is entering the area. The inorganic N/P mass ratio has decreased in the last 45 years indicating that the limiting nutrient factors has been changes from phosphate in 1941/42 to nitrogen in 1986/87. The seston volume, measured by filtering 100 L of water through a plankton net (50 microm) has generally been doubled. Based on the relations between biological oxygen demand and chlorophyll-a and between transparency and seston volume in 1986/87, chlorophyll-a and transparency has been assessed in 1941/42. It is concluded that the average chlorophyll-a content in the lakes has doubled or tripled in the last 45 years and that the mean transparency in the Gouwe Canal is reduced from 75 to 50 cm. The results of the continued investigation can possibly be used to develop ecological objectives for combating eutrophication in canals and lakes. (Miller-PTT)
W89-05989

SOURCES AND DISTRIBUTION OF HYDROCARBONS IN BRIDGEWATER BAY (SEVERN ESTUARY, U.K.) INTERTIDAL SURFACE SEDIMENTS,
Royal Holloway and Bedford New Coll., Egham (England). Dept. of Chemistry.
S. D. Killops, and V. J. Howell.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 8, No. 6, p 237-261, September 1988. 12 fig, 6 tab, 44 ref.

Descriptors: *Hydrocarbons, *Path of pollutants, *Estuaries, *Marine sediments, *Geochemistry, *Water pollution sources, *Intertidal areas, *Oil pollution, Bristol channel, Liquid chromatography, Gas chromatography, Mass spectrometry, Pesticides, Polycyclic aromatic hydrocarbons, Petrology, Bioindicators, Oil shale.

Hydrocarbon distributions in two intertidal, surface sediments from Bridgewater Bay were examined by high performance liquid chromatography, gas chromatography and gas chromatography/mass spectrometry to investigate distributions and sources of hydrocarbons. Two major hydrocarbon sources were identified, pyrogenic polycylic aromatic hydrocarbons and a chronic petrogenic input. Other probable sources were algal, higher plant and DDT-related pesticides. It was not possible to detect a contribution to the surface sediments from a nearby Liassis shale. Petrogenic biomarker distributions were broadly similar in the sediment samples, possibly reflecting a degree of resuspension and mixing of sediments within Bridgewater Bay. However, the significance of some slight differences in steroidal hydrocarbon distributions could not be determined. A relatively greater contribution from the petrogenic sources than from the pyrogenic source was noted in the finer grained sediment sample. An extended range of polycyclic aromatic hydrocarbons was noted in both sediment samples, with molecular weights of up to 326 detected. A group of compounds (comprising terphenyls, cyclohexylbiphenyls and dicyclohexylbenzenes) which appeared to have a petrogenic origin was detected. (Author's abstract)
W89-05990

TWO-DIMENSIONAL FOURTH-ORDER SIMULATION FOR SCALAR TRANSPORT IN ESTUARIES AND COASTAL SEAS,
Institut de Biogeochimie Marine, Paris (France).
K. D. Nguyen, and J. M. Martin.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 8, No. 6, p 263-281, September 1988. 9 fig, 26 ref.

Descriptors: *Solute transport, *Model studies, *Simulation analysis, *Path of pollutants, *Estuaries, *Coastal waters, *Advection, Fate of pollutants, Numerical models, Nitrates, Scalar transport, Error analysis.

A fourth order scheme for solving the strong advection problem in estuaries and coastal seas is presented. The scheme is based on the characteristic method in conjunction with a bi-cubic interpolation for solving the advection term, and the implicit differences following fractional steps for the diffusion term. The amplitude of and phase error analysis and the one- and bi-dimensional tests carried out, have shown that the proposed scheme is more accurate than other ones, such as the upwind, leap-frog and Durfort-Frankel, Leenderste's ADI schemes. It is almost equivalent to the four-point fourth-order one, allowing a considerable decrease on the computing time and the storage requirement over the last. An application of the scheme to predicting the pollution by nitrates in the Moulinets cove (France) is given to illustrate this scheme. The proposed method enables the spread of scalar quantities in estuarine and coastal seas to be simulated and predicted. In the studied area, the Vauville coastline is not polluted by nitrates. However, the pollution of the areas located 2.5 km from the east and north shorelines is quite high. However, it must be remembered that nitrates exist only in a thin surface layer, and, moreover, the residence time of such spots is normally about 2-3 h. The pollution, therefore, is not a major problem for the environmental protection of the studied zone. (Miller-PTT)
W89-05991

EFFECTS OF OXYGEN ON HYDROCARBON DEGRADATION STUDIES IN VITRO IN SURFICIAL SEDIMENTS,
Aix-Marseille-2 Univ. (France).
G. Mille, M. Mulyono, T. El Jammal, and J.-C. Bertrand.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 8, No. 6, p 283-295, September 1988. 4 fig, 4 tab, 36 ref.

Descriptors: *Oil pollution, *Marine sediments, *Microbial degradation, *Hydrocarbons, *Oxygen, *Fate of pollutants, Dissolved oxygen, Biodegradation, Flow-through systems, Oxidation-reduction potential, Oil physicochemical properties.

The degradation of selected hydrocarbons (nC19, nC20, pristane and phenanthrene), no. 1 fuel oil and endogenous hydrocarbons in heavily polluted marine sediments was investigated as a function of dissolved oxygen concentration in the overlying water. Continuous flow-through systems were used in order to maintain or control physicochemical parameters. Under such conditions, the role of oxygen on the percentages of biodegradation was determined. Hydrocarbon degradation occurred markedly in sediments where the dissolved oxygen concentration in the overlying seawater was 8 ppm and the redox potential was around +150 mv. The degradation was slower (2 to 3 times) when the dissolved oxygen concentration (2-3 ppm) and the redox potential (+30 mv) decreased. Under suboxic conditions (dissolved oxygen of 0.2 to 0.3 ppm and redox potential between -180 and -200 mv), no degradation was detected. (Author's abstract)
W89-05992

WATER RESOURCES AND ENVIRONMENTAL POLLUTION IN NIGERIA: SOME PRELIMINARY FINDINGS,
Nigerian Inst. of Social and Economic Research, Ibadan.
K. Adeniji.
Journal of Environmental Management JEVMAW, Vol. 27, No. 3, p 229-235, October 1988. 1 fig, 10 ref.

Descriptors: *Water quality control, *Nigeria, *Economic development, *Urbanization, *Water pollution, *Water pollution sources, Oil pollution, Domestic wastes, Industrial wastewater, Environmental protection, Public policy, Research priorities.

Based on recent research efforts, the impact of urbanization and economic development on water resources in Nigeria is examined. Pollution, (including industrial effluents, domestic wastewater and oil pollution) is a by-product of economic growth and technological advancement. Governments in Nigeria should strike a balance between economic growth and the tolerable safety levels of pollution in the environment and its resources, including water. All levels of society need to be concerned to ensure that in our quest for socio-economic growth, the resources necessary for future existence are not destroyed. The need for continuing research in finding solutions to these problems is emphasized. Both the private and public sectors of the economy should fund research efforts so that the present and future generations of this country can make use of less polluted water resources for desired purposes. (Miller-PTT)
W89-06004

FIELD AND EXPERIMENTAL STUDY OF THE BIOACCUMULATION OF SOME TRACE METALS IN A COASTAL FOOD CHAIN: SESTON, OYSTER (CRASSOSTREA GIGAS), DRILL (OCENEBRA ERINACEA),
Nantes Univ. (France). Centre de Dosage des Elements Traces.
C. Amiard-Triquet, J. C. Amiard, B. Berthet, and C. Metayer.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 13-21, 1988. 2 fig, 5 tab, 22 ref. French Ministry of Environment Grant 83187.

Descriptors: *Trace metals, *Bioaccumulation, *Food Chains, *Oysters, *Gastropods, *Coastal waters, *Seston, *Path of pollutants, Metabolism, France, Fate of pollutants, Cadmium, Copper,

Lead, Zinc, Biological magnification, Seawater, Phytoplankton, Absorption.

From March 1982 to May 1984, monthly sampling has been carried out in a comparatively unpolluted coastal area (bay of Bourgneuf, France), allowing the determination of Cd, Cu, Pb and Zn concentrations in water and in the different links of the studied food chain. Except for Pb, the higher the metal level, the higher the trophic level. In order to determine if this situation results from a real biomagnification in the food chain or from specific abilities to concentrate trace metals, oysters and drills were exposed to metals from different sources. Young oysters were exposed for 4 weeks, simultaneously to Cu and Pb, through seawater and/or food. The body burden of Cu and Pb in oysters and their concentrations were evaluated after 12, 20, and 28 days of exposure. In controls and oysters contaminated via food, the body burden of Pb decreased during the experiment. Moreover, the direct uptake from water led to body burdens approximately 100 times higher than those reached after contaminated food ingestion. For Cu, the body burden increased during the experiment in controls as well as in oysters fed with contaminated phytoplankton. The body burdens induced by exposure to contaminated seawater or seawater + food are at least ten times higher than those registered in oysters exposed via phytoplanktonic food. Drills were placed for 6 weeks in plastic net bags containing no food or food with different levels of metals. No significant differences were observed between the levels of Cd, Cu, and Zn in controls and in drills of the three groups, indicating that these levels do not depend on the food. (Author's abstract)
W89-06015

MULTIPLE TOXICITY AND ACCUMULATION OF HEAVY METALS IN TWO BIVALVE MOLLUSC SPECIES,
Tvarminne Zoological Station (Finland).
For primary bibliographic entry see Field 5C.
W89-06016

TRANSFER OF HEAVY METALS FROM SUSPENDED SEDIMENTS TO THE ALGA STICHOCOCCUS BACILLARIS IN AN ESTUARINE WATER MEDIUM,
Technische Univ. Hamburg-Harburg (Germany, F.R.). Arbeitsbereich Umweltschutztechnik.
W. Ahlf.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 33-38, 1988. 3 fig, 1 tab, 11 ref.

Descriptors: *Heavy metals, *Algae, *Suspended sediments, *Estuarine environment, *Path of pollutants, *Bioaccumulation, Bioassays, Salinity, Particulate matter.

A bioassay has been carried out to determine the uptake of selected heavy metals from resuspended freshwater sediment by Stichococcus bacillaris. An apparatus was used in which a 0.45 micron pore diameter membrane separated the algae and particulates. When used with an estuarine water medium, this method demonstrated the release of heavy metals from particulates and subsequent bioaccumulation for some metal species. The amounts of metals accumulated in the algae indicated that the influence of salinity was important for distributions of metals in water, particulates, and algae. (Author's abstract)
W89-06017

REMOVAL OF HEAVY METALS FROM SEDIMENTS BY MANGROVES IN JIULONG ESTUARY, XIAMEN HARBOUR, CHINA,
Xiamen Univ. (China). Inst. of Environmental Science.
W. Yuduan, L. Changyi, H. Jiandong, and L. Yuling.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 49-54, 1988. 3 fig, 2 tab, 11 ref.

Descriptors: *Fate of pollutants, *Bioaccumulation, *Heavy metals, *Mangrove swamps, *China, *Sediments, *Path of pollutants, Estuaries, Regression analysis.

Sediment samples were collected from Jiulong Estuary (Xiamen Harbor, Fujian, China), where five major species of mangrove grow well, even though the levels of the heavy metals Cu, Pb, and Hg from anthropogenic sources in the sediments of the region are as high as 18.1 ppm, 59.2 ppm, and 0.14 ppm, respectively. The concentrations of Cu, Pb, Hg, Mn, Fe, and P in leachate from sediment leached with 0.5 N HCl, as well as the total carbon (TC) content and analysis was used to assess the experimental data. The removal of such heavy metals as Hg from sediments by mangroves was estimated to be up to 6.5% of the weakly bound species. The authors suggest that mangrove ecosystems may be used as a cheap method of treating industrial waste containing low levels of heavy metals. (Author's abstract)
W89-06019

DEGRADATION OF TRIBUTYL TIN AND DIBUTYL TIN COMPOUNDS IN ENVIRONMENTAL WATERS,
Environmental Pollution Control Center, Osaka (Japan).
Y. Hattori, A. Kobayashi, K. Nonaka, A. Sugimae, and M. Nakamoto.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 71-76, 1988. 12 fig, 3 ref.

Descriptors: *Pesticides, *Antifouling paints, *Degradation, *Tin, *Fate of pollutants, *Organotin compounds, Pollutants, Japan, Riparian waters, Seawater, Chemical degradation.

The degradation of tri-n-butyl tin (TBT) and di-n-butyl tin (DBT) compounds in river and seawater samples was studied. In river water (Daini Neya River), TBT was degraded with time, and the concentration of inorganic tin increased. DBT was also degraded with time, and the concentrations of n-butyl tin (MBT) compounds and inorganic tin (the degradation products) increased. The half lives of TBT and DBT were about 11 days and 5 days, respectively. In seawater from Sakaisenboku Harbour (one of the most polluted areas in Osaka Bay), TBT and DBT were degraded in a manner similar to that in Daini Neya River water, but in seawater from other areas of Osaka Bay these compounds were little degraded. (Author's abstract)
W89-06022

TOXIC CHEMICAL POLLUTION OF THE ST. LAWRENCE RIVER (CANADA) AND ITS UPPER ESTUARY,
National Water Research Inst., Burlington (Ontario). Lakes Research Branch.
R. J. Allan.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 77-88, 1988. 6 fig, 28 ref.

Descriptors: *Fate of pollutants, *Toxicity, *Pollutant identification, *St. Lawrence River, *Path of pollutants, *Chemical wastes, *Canada, *Estuaries, Whales, Water pollution effects.

Decline of the Beluga whale population in the upper estuary of the St. Lawrence River may be related to the high content of toxic metals and organic chemicals in their tissues. For three years, the National Water Research Institute has conducted research cruises of the St. Lawrence River to identify the major toxic chemical pollutants in the river and to determine their transport to, and fate in, the upper estuary. The impact of toxic chemicals in the estuarine zone is tied not only to their fate in the increasing salinity and turbidity zone of the upper estuary but to their source, transport mechanisms, and fate in the upstream river. (Author's abstract)
W89-06023

SORPTION BEHAVIOUR OF WASTE-GENERATED TRACE METALS IN ESTUARINE WATERS,
Plymouth Polytechnic (England). Inst. of Marine Studies.
G. A. Glegg, J. G. Titley, G. E. Millward, D. R. Glasson, and A. W. Morris.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 113-121, 1988. 4 fig, 2 tab, 22 ref.

Descriptors: *Path of pollutants, *Estuaries, *Sorption, *Trace metals, *Chemical wastes, Particle shape, Porosity, Kinetics, England, Turbidity, Iron, Manganese.

Samples of suspended particles have been collected from the turbidity maximum region of the Tamar Estuary, S.W. England. Specific surface areas and porosities of the particles were determined by a BET nitrogen adsorption technique. The role of surface coatings of organic matter and Fe and Mn oxides was examined. The data show that the specific surface area was highest at the turbidity maximum and was associated with high Fe/Mn ratios. The characterized particles were then used in time-dependent adsorption-desorption experiments, with waters from the metal-rich Carnon River, S.W. England. The rates and extents of the sorption processes were interpreted in terms of a two-stage reaction which was related to the microstructures of the particles. Kinetic analysis of the desorption profiles gave rate constants which are of significance in the prediction of the fate of toxic metal wastes discharged into estuaries. (Author's abstract)
W89-06026

RESUSPENSION OF SEDIMENTS FROM LONG ISLAND SOUND (U.S.A.),
California Univ., Santa Barbara. Dept. of Mechanical and Environmental Engineering.
For primary bibliographic entry see Field 2J.
W89-06030

EFFECT OF SALINITY ON NITRIFICATION IN A TIDAL RIVER,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2H.
W89-06031

ROLE OF FINE SEDIMENT BEHAVIOUR IN POLLUTANT TRANSFER MODELLING,
Blackdown Consultants Ltd., Taunton (England).
For primary bibliographic entry see Field 2J.
W89-06032

TWELVE YEARS OF OBSERVATIONS OF MERCURY CONCENTRATIONS IN YATSUSHIRO SEA (JAPAN),
Nagasaki Univ. (Japan). Faculty of Fisheries.
S. Miyahara, M. Schintu, T. Kauri, and A. Kudo.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 193-197, 1988. 1 fig, 2 tab, 7 ref.

Descriptors: *Fate of pollutants, *Mercury, *Path of pollutants, *Japan, Marine sediments, Marine environment, Water pollution, Heavy metals, Monitoring, Human pathology, Bays, Rivers, Coastal waters, Toxicity.

The fate of the mercury which caused the tragedy of Minamata disease has been monitored for a period of 12 years determining mercury contents in the surface sediment of Yatsushiro Sea. Twenty-four sampling stations were selected over an area of 636 sq km. Mercury concentrations, both organic and inorganic, in water were also determined within the Bay and the Sea in 1985. Mercury has been dispersing from the Bay to the Sea. From 1975 to 1986 there was considerable increase of mercury contents in the surface sediments. However, there is no alarming level of mercury in the sediments of Yatsushiro Sea and the level is mostly less than 1 ppm. Mercury concentrations in the water of Minamata Bay were as much as 6 times higher compared to those of Yatsushiro Sea. The highest level in the Bay was 125.3 ng/L (total mercury) whereas the highest level in the Sea was 25.8 ng/L. The proportion of organic mercury in the total mercury ranged from 0.9 % to 13.7 % in the Sea. The proportion was lower than those found in river waters. (Author's abstract)
W89-06034

SUSCEPTIBILITY OF U.S. ESTUARIES TO POLLUTION,
Delaware Univ., Newark. Coll. of Marine Studies.
E. L. Beasely, M. A. Hiller, and R. B. Biggs.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 211-219, 1988. 4 fig, 2 tab, 12 ref.

Descriptors: *Estuaries, *Water pollution effects, *Path of pollutants, *Human population, Hydrologic models, Hydraulic loading, Phosphorus, Urban watersheds, Pollution load, Nonpoint pollution sources, Nutrients, Industrial wastes, Agricultural wastes, Resources management, Stress, Water quality, Turbidity, Eutrophication.

Utilizing data primarily from the U.S. Department of Commerce, both estuaries and watersheds for 78 U.S. systems are analyzed. Watersheds are classified according to total population and discrete subpopulations. The Vollenweider approach, which compares hydraulic loading to nutrient loading of lakes, is adapted to estuaries. By considering total population as a surrogate of point source nutrients, agricultural workers as a surrogate of non-point source toxics and nutrients and chemical + metal workers as a surrogate of point source toxics, we can estimate potential anthropogenic impacts on watersheds. When these surrogates are plotted against hydraulic loading, managers have a tool to identify estuaries most likely to be under greatest anthropogenic pressure. The estuaries with highest susceptibility from total population, as well as the estuaries with the highest susceptibility to toxic stress, are identified. On a Vollenweider diagram, the phosphorous loadings of freshwater bodies are plotted as a function of hydraulic loading. The permissible-excessive phosphorous loadings have been both theoretically and empirically determined. We have replotted the freshwater data and added 33 U.S. estuary P loadings that were previously unavailable. Estuaries plot on the Vollenweider diagram as a continuum of fresh waterbodies, both in terms of hydraulic loading and phosphorus loading. Most estuaries appear to have permissible P loadings. Analysis of nutrient loading (normalized to hydraulic loading) versus water quality parameters like chlorophyll a indicates that estuaries are more efficient users of nutrients than are freshwater bodies, and that they reach a 'nutrient saturation point'. Perhaps this is due to grazing or turbidity. It appears that, in general, the OECD eutrophication modeling approach is applicable to estuarine systems as well as lakes and impoundments. (Author's abstract)
W89-06036

DISPERSION MODELLING FOR A COMPLEX ESTUARY: THE CASE OF THE TAGUS,
Universidade Nova de Lisboa (Portugal). Environmental Systems Analysis Group.
A. Carmona Rodrigues, M. Cardoso da Silva, A. Camara, T. Faria Fernandes, and J. Gomes Ferreira.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 271-276, 1988. 3 fig, 7 ref.

Descriptors: *Estuaries, *Model studies, *Path of pollutants, *Pollutant load, Hydrologic models, Portugal, Estuarine environment, Mathematical models, Recreation, Fishing, Navigation.

Estuarine dispersion models have been commonly used to define the pollutant loads permissible to achieve pre-defined water quality levels and improve our knowledge of estuarine phenomena. Those models for large estuaries with complex hydrodynamic and ecological processes usually have extremely high running times. This paper presents an approach based on the use of increasingly complex models, which attempts to circumvent the problem of initial lack of data, as well as to give some initial insight into the processes of the Tagus Estuary, within acceptable levels of precision. As a first stage, simple models were developed and applied to the estuary, one of the largest in Europe, with more than 300 sources of pollution and intensive use for recreation, fishing, and navigation. The computational exercises undertaken with these models were also used to accumulate information on the response of the Tagus Estuary to a number of forcing conditions. This information, synthesized in 'if ... then' rules, was integrated to form a data base on the estuary, which is currently being developed. The data base will organize existing information and, providing that learning mechanisms are included, it will also create new knowledge, as well as supplying the complex models under development with reasonable initial values. (Author's abstract)
W89-06043

APPLICATION OF BASIN WIDE ECOLOGICAL MODELS (BAWEMS) TO THE FATE OF LAS IN TOKYO BAY,
Osaka Univ. (Japan). Dept. of Environmental Engineering.
A. Tokai, and T. Morioka.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 287-294, 1988. 3 fig, 5 tab, 10 ref.

Descriptors: *Watersheds, *Linear alkyl sulfonates, *Bays, *Fate of pollutants, *Pollution load, *Model studies, Ecology, Simulation, Ecosystems, Sediments, Rivers, Seawater, Detergents.

The primary purpose of this study was to simulate the environmental fate of the homologs of linear alkylbenzene sulfonates (LAS). These were selected as representative chemicals with middle-range aquatic toxicity and environmental persistence, and which are used in rather large quantities. A secondary purpose was to determine the composition ratio (i.e., the relative percentages of LAS homologs) of LAS products which results in the minimum risk potential in sediments. The following results were obtained from model simulations. By applying basin wide ecological models (BAWEMs) to Tokyo Bay and the surrounding watershed, distribution patterns of LAS homologs in river water, river sediment, seawater, and sea sediment were relatively well simulated. Also, the minimum risk composition ratio of LAS, with the constraint of considering detergent cleaning capacity, is capable of reducing by about 60% the risk potential of the usual composition ratio of LAS. Reported composition ratios of LAS in existing consumer products are all in the same or rather low risk level categories. It can be concluded that an effective strategies of chemical risk management, particularly with reference to alkylbenzene-based synthetic detergents, is alteration of the composition ratio of LAS. (Author's abstract)
W89-06045

CORRELATION OF COPROSTANOL TO ORGANIC CONTAMINANTS IN COASTAL AND ESTUARINE SEDIMENTS OF THE U.S.,
National Ocean Service, Seattle, WA. Ocean Assessments Div.
G. Shigenaka, and J. E. Price.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 989-998, October 1988. 12 tab, 17 ref.

Descriptors: *Water pollution sources, *Benthic environment, *Correlation analysis, *Environmental tracers, *Coprostanol, *Marine sediments, Coasts, Municipal wastes, Monitoring, Wastewater treatment, Organic compounds.

Results from the National Status and Trends Program, an nationwide effort to evaluate U.S. coastal and estuarine environmental quality, were analyzed to provide information about regional sources of organic contaminants in the benthic environment. Spearman's rank correlation procedure was applied to measurements of coprostanol, a chemical tracer of sewage, and three classes of organic compounds in sediments. The results suggest that discharges from publicly owned treatment works are responsible for concentrations of the organic compounds encountered in the northeastern coastal region, while other sources may predominate in the other regions of the country. (Author's abstract)
W89-06054

STATISTICAL APPROACH TO ASSESS FACTORS AFFECTING WATER CHEMISTRY USING MONITORING DATA,
North Texas State Univ., Denton. Inst. of Applied Sciences.
F. M. Fisher, K. L. Dickson, J. H. Rodgers, K. Anderson, and J. Slocomb.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1017-1026, October 1988. 5 fig, 1 tab, 18 ref.

Descriptors: *Model studies, *Statistical analysis, *Statistical models, *Water quality, *Rivers, *Stream pollution, Chemical properties, Monitoring, Data interpretation, Hydrologic models, River flow, Sulphur River.

A method to partition the variation in concentrations of water chemistry parameters in a river consists of fitting a family of curves for each chemical parameter. Each curve indicates the response of the parameter to river flow for a particular time period or location. An analysis of covariance is then used to identify statistically significant differences between curves. Such differences result largely from two factors: (1) the discharge of effluents and (2) river flow-concentration relationships. The deviations from the fitted curves indicate month-to-month variations unrelated to river flow that are controlled by factors such as temperature-related seasonal patterns. Underlying statistical assumptions are discussed with respect to water chemistry data. The technique was applied to a data set consisting of monthly samples of 22 water chemistry parameters from the Sulphur River of Texas and Arkansas. Several patterns of response to river flow and to two effluent discharges were revealed. (Author's abstract)
W89-06057

NATIONWIDE REGRESSION MODELS FOR PREDICTING URBAN RUNOFF WATER QUALITY AT UNMONITORED SITES,
Geological Survey, Reston, VA.
G. D. Tasker, and N. E. Driver.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1091-1101, October 1988. 5 tab, 10 ref.

Descriptors: *Urban hydrology, *Water pollution sources, *Regional analysis, *Regression analysis, *Urban runoff, *Water quality, *Runoff, Least squares method, Pollution load, Model studies, Chemical oxygen demand, Ammonia, Nitrogen, Phosphorus, Copper, Lead, Zinc, Suspended solids.

Regression models are presented that can be used to estimate mean loads for chemical oxygen demand, suspended solids, dissolved solids, total ammonia plus nitrogen, total phosphorus, total copper, total lead, and total zinc at unmonitored sites in urban areas. Explanatory variables include drainage area, imperviousness of drainage basin to infiltration, mean annual rainfall, a land-use indicator variable, and mean minimum January temperature. Model parameters are estimated by a generalized-least-squares regression method that accounts for cross correlation and differences in reliability of sample estimates between sites. The regression models account for 20-65% of the total variation in observed loads. (Author's abstract)
W89-06066

SIMULATED TRANSPORT OF MULTIPLE CATIONS IN SOIL USING VARIABLE SELECTIVITY COEFFICIENTS,
Florida Univ., Gainesville. Dept. of Soil Science.
For primary bibliographic entry see Field 2K.
W89-06070

INDEPENDENT CALIBRATION OF MECHANISTIC-STOCHASTIC MODEL FOR FIELD-SCALE SOLUTE TRANSPORT UNDER FLOOD IRRIGATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
For primary bibliographic entry see Field 2K.
W89-06071

SOLUBILITY OF BARIUM ARSENATE,
University of Wyoming Research Corp., Laramie. Western Research Inst.
M. E. Essington.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1566-1570, November-December

1988. 2 fig, 2 tab, 26 ref.

Descriptors: *Path of pollutants, *Leaching, *Arsenic compounds, *Solubility, Equilibrium, Barium.

The ability to predict the path and behavior of arsenic in soils and waste affected environments requires a knowledge of the processes that control arsenic distribution between solid and solution phases. One process that may control soluble arsenic in aerated environments is the precipitation of metal arsenates. Current thermodynamic data suggest barium arsenate (Ba3(AsO4)2(c)) to be a highly stable phase. However, sufficient evidence is available to question the validity of the current data. In order to determine the solubility and calculate the standard free energy of formation, an equilibrium solubility study was conducted. The equilibrium experiments were carried out under three different ionic strength conditions for reaction times up to 45 days. Equilibrium was approached from both undersaturated and supersaturated initial conditions. The solubility for the dissolution of barium arsenate was calculated to be 21.62. Correspondingly, the standard free energy of formation of -3101.2 plus or minus 2.0 kJ/mol was calculated. This value is 166.9 kJ/mol more positive than the current literature value. Reevaluation of the solubility data from a previous work suggests that the solubility for the dissolution of barium arsenate is 24.64 and the corresponding standard free energy of formation is -1587.0 plus or minus 2.5 kJ/mol. (Davis-PTT)
W89-06075

ADSORPTION OF THIRAM AND DIMETHOATE ON ALMERIA SOILS,
Departmento de Quimica Inorganica, Colegio Universitario de Almeria, 04071 Almeria, Spain.
A. Valverde-Garcia, E. Gonzalez-Pradas, M. Villafranca-Sanchez, F. Del Rey-Bueno, and A. Garcia-Rodriguez.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1571-1574, November-December 1988. 2 fig, 5 tab, 17 ref.

Descriptors: *Fungicides, *Pesticides, *Path of pollutants, *Agricultural chemicals, *Adsorption, Pollutants, Soil properties, Thiram, Dimethoate, Almeria, Spain, East Andalucia, Insecticides.

Adsorption of pesticides by soil is one of the most important factors affecting their bioavailability, degradation, volatilization, and transportation to aquatic environments. The adsorption process of thiram and dimethoate on Almeria (East Andalucia, Spain) soils from aqueous solutions at 30 C has been studied. The adsorption isotherms may be classified as L type of the Giles classification. The Freundlich equation values (K sub f) vary between 4.81 and 13.73 for the fungicide thiram (tetramethylthiuram disulfide) and between 1.06 and 8.95 for the insecticide dimethoate (O,O dimethyl S-(N methylcarbamoylmethyl) phosphorodithioate) depending on the soil type. In relation to the correlations between adsorption parameters and soil properties, the adsorption process of thiram seems to be conditioned by the soil organic matter content whereas the adsorption of dimethoate is fundamentally conditioned by specific surface area and by cation exchange capacity. (Davis-PTT)
W89-06076

DYNAMICS OF ALUMINUM COMPLEXATION IN MULTIPLE LIGAND SYSTEMS,
Savannah River Ecology Lab., Aiken, SC. Div. of Biogeochemistry.
M. A. Anderson, and P. M. Bertsch.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1597-1602, November-December 1988. 5 fig, 33 ref. DOE Contract AC09-76SR00819.

Descriptors: *Acid rain effects, *Path of pollutants, *Kinetics, *Aquatic environment, *Metal complexes, *Aluminum, Multiple ligand systems, Toxicity, Fluoride, Oxalate, Citrate, Chromatography.

The complexation of metal ions with inorganic and organic ligands present in natural waters determines the movement of the metals in the environment, including their transport, uptake, and toxicity. The role of complexing ligands in attenuating aluminum (Al) toxicity and in influencing Al transport in soils and waters has been recognized for some time though the kinetics of such complexation reactions within complicated multi-ligand aqueous solutions have not been previously evaluated. The dynamics of Al complexation in the presence of multiple ligands, specifically fluoride (F), oxalate (Ox), and citrate (Cit), were studied using an ion chromatographic speciation method. The rate constant for formation of AlF(2+) under the experimental conditions was 12.3 plus or minus 1.1/M/s in the absence of competing ligands, but was observed to increase to 23.4 plus or minus 0.6 and 52.0 plus or minus 5.7/M/s in the presence of Ox and Cit, respectively. The rate of formation of the AlOx(+) complex was more rapid than that of AlF(2+) and was unaffected by the presence of F. Citrate complexed with Al sufficiently rapidly that the constant could not be determined. That the constant for AlF(2+) increased in the presence of competing ligands contradicts the accepted dogma on the kinetics of concurrent reactions, where reactions are envisioned to proceed independently and in relative isolation. Al citrate formation in the presence of F was found to exceed the thermodynamically imposed equilibrium level and necessarily reequilibrated to a lower solution concentration as the slower Al-F complexation reaction proceeded, though no such behavior was witnessed for Aloxalate (+) formation in the presence of F. (Author's abstract)
W89-06080

SALT-INDUCED MANGANESE SOLUBILIZATION IN CALIFORNIA SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
R. A. Khattak, and W. M. Jarrell.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1606-1611, November-December 1988. 5 tab, 36 ref.

Descriptors: *Salinity, *Soil water, *Water pollution sources, *Manganese, *Soil Types, *Solubility, California, San Bernardino, Fresno, Riverside, Orange, El Dorado, Santa Cruz, Loam.

The solubility of manganese (Mn) in soil solution depends on soil pH, redox potential, amount and type of higher valency Mn oxides, and a variety of organic and inorganic soil constituents. The extent of salt induced Mn release was studied from a variety of California soils: sandy loam, clay loam, fine sand, clay, and stony clay loam. To investigate the effect of salinity and time of incubation on Mn release, Redding clay loam and Hanford sandy loam soils were saturated with 0, 75, and 150 mol/cu m NaCl-CaCl2 solution and incubated in a glasshouse for 0, 2, 4, 7, and 10 d. The Mn concentration in the soil saturation extract increased 2- to 4-fold with time of incubation at all levels of salt solution and 7- to 16-fold with increasing salt concentrations at a given incubation time. Increase in Mn with time and increase in pH in the nonamended soil suggest reduction of Mn oxides while increases in Mn with increasing salt levels implicate the release of Mn into soil solution through reduction of Mn oxides, displacement by Na(+) and Ca2(-) and/or ligand (Cl-) complexation processes. Mn release by NaCl-CaCl2 salinity was also investigated in 20 California soils varying in pH, easily reducible Mn (hydroquinone + NH4OAc), total Mn (HF-HNO3-HClO4) and in total C concentrations. These soils were saturated with 0, 37.5, 75.0, 112.5, and 150.0 mol/cu m NaCl-CaCl2 solution and extracted after 5 d of incubation in a glasshouse. Depending upon soil pH, easily reducible and total soil Mn levels, the Mn in soil saturation extracts increased from 10 to 4000 mmol/cu m for 150 mol/cu m NaCl-CaCl2 levels over the nonsaline (deionized water) treatments. Multiple regression analysis showed that Mn solubility in salt-amended soils was mainly related to soil pH, easily reducible and total Mn. Factors related to geochemical environments might explain the variations in Mn solubility in salt amended soils. (Author's abstract)
W89-06082

BICARBONATE ESTIMATION FROM ALKALINITY DETERMINATIONS FOR NEUTRAL TO ACIDIC LOW ALKALINITY NATURAL WATERS: THEORETICAL CONSIDERATIONS,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 7B.
W89-06092

NOAA GULF OF MEXICO STATUS AND TRENDS PROGRAM: TRACE ORGANIC CONTAMINANT DISTRIBUTION IN SEDIMENTS AND OYSTERS,
Texas A and M Univ., College Station. Dept. of Oceanography.
T. L. Wade, E. L. Atlas, J. M. Brooks, M. C. Kennicutt, and R. G. Fox.
Estuaries ESTUDO, Vol. 11, No. 3, p 171-179, September 1988. 4 fig, 3 tab, 26 ref. NOAA Grant 50-DGNC-5-00262.

Descriptors: *Path of pollutants, *Water pollution sources, *Gulf of Mexico, *Trace levels, *Sediments, *Oysters, *Halogenated pesticides, *Polychlorinated biphenyls, Contamination, Mollusks, Tissue analysis, Aromatic compounds, Hydrocarbons, Pesticides, Coastal waters, Organic compounds, Water pollution.

Polynuclear aromatic hydrocarbons (PAH), chlorinated pesticides, and polychlorinated biphenyls (PCB) concentrations were determined in sediment and oysters to provide information on the current status of the concentration of these contaminants in Gulf of Mexico coastal areas removed from point sources of input. Coprostanol analyses of sediments showed that anthropogenic materials are associated with the sediments at all 153 stations sampled. The levels of contaminants encountered are low compared with areas of known contamination. Average PAH concentrations are nearly the same in oysters and sediments, although the molecular weight distribution is different. Average DDT and PCB concentrations are higher by a factor of 10 to 130 in oysters as compared to sediments. Continued sampling and analyses will allow for long-term trends in the concentrations of these contaminants to be determined. (Author's abstract)
W89-06096

THRESHOLD DETECTION VALUES OF POTENTIAL FISH TAINTING SUBSTANCES FROM OIL SANDS WASTEWATERS,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5A.
W89-06103

POTENT ODOUR-CAUSING CHEMICALS ARISING FROM DRINKING WATER DISINFECTION,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W89-06109

CHEMISTRY OF OFF-FLAVOURS IN MARINE ORGANISMS,
Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Food Research.
F. B. Whitfield.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 63-74, 1988. 3 tab, 37 ref.

Descriptors: *Arsine, *Phenols, *Taste, *Foods, *Water pollution sources, *Organoleptic properties, *Marine animals, Crustaceans, Algae, Detritus, Invertebrates, Organic compounds, Water pollution, Water pollution effects, Chemistry.

Two compounds, trimethylarsine and 2,6-dibromophenol, were shown to cause, respectively, garlic and iodoform-like off-flavors in some species of Australian prawns. Both compounds have extremely low threshold values in water; the odor threshold of trimethylarsine is 2 ng/L, and the flavor threshold of 2,6-dibromophenol is 0.5 ng/L. Hence, even though they occur in prawns in only

micrograms/kg concentrations, they can lead to consumer rejection of contaminated material. Both of these compounds appear to be natural components of the environment. Trimethylarsine is a metabolite of two common microorganisms, and 2,6-dibromophenol is a component of algae, bryozoa, and a marine worm. These compounds, among others, demonstrate the detrimental impact that the natural environment can have on the acceptability of seafoods. In the past, these flavors were accepted as natural by local populations and even regarded as desirable. However, these flavors are often unacceptable to other consumers, particularly those in cities and export markets. With an increasing tendency for the fishing industry to market its products well away from their place of origin, new handling and processing procedures, such as deheading, will need to be introduced to reduce the impact of off-flavor compounds in the retailed product and to prevent the destruction of material which is otherwise safe and nutritious. (Author's abstract)
W89-06110

BIOCHEMISTRY OF BIOGENIC OFF-FLAVOUR COMPOUNDS IN SURFACE WATERS,
Tuebingen Univ. (Germany, F.R.). Inst. fuer Chemische Pflanzenphysiologie.
F. Juttner.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 107-116, 1988. 3 fig, 1 tab, 56 ref.

Descriptors: *Odor-producing algae, *Biochemistry, *Water pollution sources, Organoleptic properties, Hydrocarbons, Alcohols, Aromatic compounds, Sulfur compounds, Algae, Lakes, Cyanophyta, Plant physiology, Metabolism, Enzymes, Taste.

Nor-carotenoids, unsaturated hydrocarbons, aldehydes, ketones and alcohols, thio compounds, terpenoids, phenols, and aromatic hydrocarbons are important biogenic odor compounds frequently found in freshwater. Results of biochemical studies of members of the above list are presented. Olefinic hydrocarbons, such as ectocarpine, are secreted by phytoplankton, especially diatoms, and occur in the essential oils of various marine brown algae. Aromatic compounds such as benzene, toluene, and xylenes are ubiquitous in surface and groundwaters. Although increased concentrations of these compounds are generally taken as an indication of pollution, biogenic formation of toluene is widespread and occurs whenever anoxic environments are found. The seasonal distribution of the formation of toluene, benzene, and p-cresol suggests that their precursors are phenylalanine and tyrosine from the protein of sedimenting phytoplankton. Nor-carotenoids are formed by particular strains of blue-green algae. Lipoxygenase products are found in all lake water, and all members of the Chrysophyceae studied are potent producers of unsaturated aldehydes. Sulfur compounds most frequently found in lake water are dimethyl sulfide and dimethyl disulfide. Some sulfur compounds are found independently of planktonic species present, while others are invariably associated with particular microorganisms. (Doria-PTT)
W89-06115

BLUE-GREEN ALGAE IN LAKE BIWA WHICH PRODUCE EARTHY-MUSTY ODORS,
Kyoto Municipal Water Works Bureau (Japan). Water Quality Lab.
T. Negoro, M. Ando, and N. Ichikawa.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 117-123, 1988. 2 fig, 4 tab, 15 ref.

Descriptors: *Odor-producing algae, *Cyanophyta, *Algae, *Lake Biwa, Japan, *Odors, *Water pollution sources, Organoleptic properties, Drinking water, Water quality, Water quality management, Plankton, Oscillatoria, Anabaena, Organic compounds, Odor control.

Since 1969, earthy-musty odor problems have frequently occurred in the water supply system of Kyoto City. Though the causes of these off-flavors were identified as 2-methylisoborneol (MIB) and geosmin, the causative organisms were not identified until recently. Now, three species of planktonic blue-green algae from Lake Biwa have been identified as playing important roles in such problems. From the unialgal culture of each alga, Anabaena macrospora was shown to produce geosmin, and both Phormidium tenue and Oscillatoria tenuis to produce MIB. These odorous compounds were found to be mainly stored in trichomes, although it was once thought that they were dissolved in the surrounding water. Therefore, most of the odorous compounds can be removed from the water when the causative algae are removed. (Author's abstract)
W89-06116

FACTORS INFLUENCING GEOSMIN PRODUCTION BY THE CYANOBACTERIUM OSCILLATORIA BREVIS,
National Inst. of Public Health, Oslo (Norway). Dept. of Water and Hygiene.
H. Naes, H. C. Utkilen, and A. F. Post.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 125-131, 1988. 4 fig, 20 ref.

Descriptors: *Cyanophyta, *Oscillatoria, *Geosmin, *Taste, *Organoleptic properties, Biochemistry, Metabolism, Algae, Culturing techniques, Physiological ecology, Pigments, Chlorophyll a, Carotenoids.

Environmental factors affecting geosmin production by Oscillatoria brevis were investigated under laboratory conditions using continuous culture techniques. Transition from light to nutrient limited growth conditions caused a two-fold decrease in geosmin production. However, geosmin content increased relative to pigment content (chlorophyll a and carotenoids). It has been suggested that geosmin biosynthesis in O. brevis proceeds via the isoprenoid pathway as was found in actinomycetes. Accordingly, the effect of inhibitors of the intermediate stages in this synthetic pathway was investigated in order to study the regulation of geosmin production in relation to pigment synthesis. It was concluded that geosmin seemed to function as an overflow metabolite in this pathway. Due to the only modest changes in geosmin production per dry weight compared to changes in biomass levels during light-limited or nutrient-limited growth, contamination of eutrophic fresh waters with geosmin appears to depend mainly on the species present and its biomass level, and only to a limited extent on nutrient enhanced synthesis. (Author's abstract)
W89-06117

MUSTY ODOUR PROBLEMS IN LAKE BIWA 1982-1987,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
M. Yagi.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 133-142, 1988. 9 fig, 4 tab, 6 ref.

Descriptors: *Odor-producing bacteria, *Lake Biwa, Japan, *Odors, *Water pollution sources, *Cyanophyta, Organoleptic properties, Algae, Plankton, Lakes, Seasonal variation, Anabaena, Oscillatoria, Water quality.

Results obtained by two research groups investigating the musty odor problem in Lake Biwa during the years 1967 to 1987 are presented. The study has shown that the problem is caused by the growth of three species of planktonic blue-green algae in the southern lake: Phormidium tenue, Anabaena macrospora, and Oscillatoria tenuis. These algae produce as metabolites either 2-methylisoborneol (MIB) or geosmin, and it is these compounds which give rise to the musty odor. Recently, the musty odor problem has expanded from the western to eastern part in the southern lake. The occurrence of the problem has also changed from spring to early summer and more recently it has begun to appear also during the autumn months. In autumn, the musty odors occur earlier in the eastern part than in the western part of the lake, and the organism responsible for the problem is either A. macrospora or O. tenuis. The maximum concentrations for geosmin and MIB, 1,050 and 860 ng/L, recorded for the lake occurred in the autumn of 1985. (Doria-PTT)
W89-06118

EFFECT OF ENVIRONMENTAL FACTORS ON GEOSMIN PRODUCTION BY FISCHERELLA MUSCICOLA,
Academia Sinica, Taipei (Taiwan). Inst. of Botany.
J. T. Wu, and F. Juttner.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 143-148, 1988. 3 fig, 3 tab, 22 ref.

Descriptors: *Odor-producing algae, *Geosmin, *Fischerella, *Cyanophyta, *Odors, Physiological ecology, Organoleptic properties, Algae, Plant physiology, Chromatography, Gas chromatography, Mass spectrometry, Sample preparation, Methanol, Chemical analysis, Culturing techniques, Proteins, Anaerobic conditions, Temperature.

The production of geosmin by axenic cultures of Fischerella muscicola (ATCC 29114) was analyzed by gas chromatography and mass spectrometry. A methanol based extraction procedure preceding closed loop stripping was successfully applied for quantitative analysis. The major part of geosmin produced by this cyanobacterium was bound in the cells. Less than 1% of the total geosmin was released. The content of geosmin in cells varied with culture conditions. Higher concentrations (based on protein amount) were observed in lag phase cultures and under anaerobic growth conditions. The synthesis of geosmin was temperature-dependent showing minimum percentage concentrations at the optimum growth temperature (30 C). Heat shock treatment at 47 C did not affect the subsequent production of geosmin. (Author's abstract)
W89-06119

IDENTIFICATION OF VOLATILE METABOLITES PRODUCED BY BLUE-GREEN ALGAE,
Tokyo Metropolitan Research Lab. of Public Health (Japan).
For primary bibliographic entry see Field 5A.
W89-06120

CHEMICAL ECOLOGY AND OFF-FLAVOUR SUBSTANCES,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 7B.
W89-06123

EARTHY-MUSTY ODOR-PRODUCING CYANOPHYTES ISOLATED FROM FIVE WATER AREAS IN TOKYO,
Tokyo Metropolitan Research Lab. of Public Health (Japan).
A. Matsumoto, and Y. Tsuchiya.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 179-183, 1988. 1 fig, 1 tab, 10 ref.

Descriptors: *Odor-producing algae, *Odors, *Cyanophyta, *Tokyo, *Water quality, *Water pollution sources, Organoleptic properties, Algae, Pollutant identification, Oscillatoria, Aphanizomenon, Ponds, Rivers, Reservoirs, Cooling towers, Culturing techniques, Fish ponds, Isolation.

A study was undertaken to determine the correlation between species of blue-green algae and their musty odor compounds, based on water samples collected from five sites in Tokyo. Odorant compounds were analyzed by gas chromatography/mass spectrometry. Blue-green algae isolated from the water bodies were cultured in the laboratory for study. In park pond water, strong odors caused by geosmin occurred when water temperature was low. Large populations of Aphanizomenon flos-aquae were observed in the pond, and isolates produced geosmin in the laboratory. A. flos-aquae was also determined to be responsible for musty odors in early spring in a fish-cultivation pond. Geosmin produced by Oscillatoria amoena in floating scums was the cause of musty odors in the Saka-gawa River, and geosmin produced by O. splendida caused an off-flavor in a reservoir on Toshima Island. The final case was a cooling tower for air conditioning from which musty odors

had been reported. An unidentified Oscillatoria sp. isolated from a mass of blue-green algae attached to the tower wall produced two compounds whose GC retention times correspond to those of 2-methylisoborneol and geosmin. (Doria-PTT)
W89-06124

NITROGEN AND THE THRESHOLD ODOR NUMBER PRODUCED BY AN ACTINOMYCETE ISOLATED FROM LAKE SEDIMENTS,
Baylor Univ., Waco, TX. Dept. of Biology.
O. T. Lind, and S. D. Katzif.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 185-191, 1988. 4 tab, 15 ref.

Descriptors: *Nitrogen, *Odors, *Bacteria, *Lake sediments, *Water pollution sources, *Waco Reservoir, Organoleptic properties, Reservoirs, Isolation, Culturing techniques, Chromatography, Gas chromatography, Mass spectrometry, Analysis of variance, Biomass, Nitrates, Ammonia, Nitrogen compounds, Correlation analysis, Rainfall, Physiological ecology.

A study was conducted to determine environmental factors which favor the production of Threshold Odor Number (TON) by an Actinomycete (Streptomyces sp.) isolated from Waco Reservoir in Texas, a reservoir with frequent taste and odor problems. The isolate was cultured under varying conditions of form and concentration of nitrogen. Geosmin produced by the isolate was identified by gas chromatography/mass spectrometry. The effect of form and concentration of nitrogen was measured as TON by an odor panel. ANOVA indicated that the TON and the cell biomass varied with the concentration of nitrogen but not the form of nitrogen supplied. There was a significantly greater TON with higher concentrations (75 to 600 micrograms N/L) of nitrate and ammonia nitrogen but not organic nitrogen. Cell biomass increased with nitrate and organic nitrogen but not ammonia nitrogen. On the other hand, TON per unit biomass (specific TON) varied with the form of nitrogen but not the concentration. Specific TON was greater with ammonia nitrogen than with either nitrate or organic nitrogen. Although the differences in specific TON with concentration were not significant, rank correlation analysis showed that high values of specific TON were associated with higher values of nitrate and ammonia nitrogen. These laboratory data support field observations that taste and odor episodes occur in the reservoir after rainfall events that supply pulses of nitrogen to the system. (Author's abstract)
W89-06125

OCCURRENCE OF MUSTY ODOR IN THE YODO RIVER,
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
Y. Hishida, K. Ashitani, and K. Fujiwara.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 193-196, 1988. 3 fig, 1 tab, 3 ref.

Descriptors: *Odor-producing algae, *Odors, *Yodo River, *Japan, *Water pollution sources, *Cyanophyta, Organoleptic properties, Rivers, Algae, Path of pollutants, Water shortage, Stagnant water, Chromatography, Gas chromatography, Mass spectrometry, Anabaena, Lake Biwa, Stagnant water.

For the past seven years, geosmin and 2-methylisoborneol (MIB) have been responsible for the occurrence of musty odors in Lake Biwa (Japan). These odorous compounds are present in the water either in solution or attached to or within the responsible blue-green algae. The concentration of geosmin decreased during its passage through the Yodo river. However, MIB was not affected. Growth of Anabaena macrospora was observed in the river in the vicinity of the weir, which prevented sea water from flowing back into the river. Because of drought in 1985, the river was dammed by the weir, producing conditions favorable to the growth of the blue-green algae. This, in turn, led to an increase of geosmin at this location. The water samples were passed through a glass fiber filter to remove the algae, and the filtrate was measured for geosmin. The concentration of geosmin in dissolved form was almost the same throughout the region of stagnant water, which indicated that the increase of geosmin downstream was caused by Anabaena macrospora. (Doria-PTT)
W89-06126

EFFECT OF CHELATING AGENTS ON THE GROWTH OF BLUE-GREEN ALGAE AND THE RELEASE OF GEOSMIN,
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
M. Miwa, and K. Morizane.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 197-203, 1988. 3 fig, 2 tab, 11 ref.

Descriptors: *Odor-producing algae, *Chelating agents, *Cyanophyta, *Metabolism, *Geosmin, *Odors, Organoleptic properties, Water quality, Algae, Plankton, Culturing techniques, Growth media, Chlorophyll a, Physiological ecology, Water pollution sources, Growth.

The effect of chelating agents on the growth of Anabaena macrospora, a planktonic blue-green alga, and on its production of geosmin was studied. When A. macrospora was cultured in CT medium containing EDTA (an artificial chelator), the maximum cell numbers were about one million cells/ml. However, in an EDTA-free CT medium, the maximum cell numbers were a tenth of the normal growth level in the complete medium. In addition, the chlorophyll a content was reduced almost a fourth, and the color of the algal cell bodies changed from green to yellow. These results showed that growth of this alga in a chelator-free medium was not healthy. At this time, though the geosmin content was constant and in the same range as in the complete medium, the ratio of the extracellular geosmin concentration in the medium to the gross concentration was 2:10 to 3:10 and 2 to 3 times its normal level. It was considered that the deterioration of the alga's physiological condition increased the release of geosmin to the medium. These results suggested that the extracellular concentration of geosmin produced by A. macrospora was affected by the alga's physiological condition. Finally, EDTA can be substituted by humic acid. When this alga was grown in a medium containing humic acid instead of EDTA, the maximum cell numbers and the release ratio of geosmin was of the same level as in the case of the complete medium. (Author's abstract)
W89-06127

ODOROUS ALGAL CULTURES IN CULTURE COLLECTIONS,
Helsinki Univ. (Finland). Dept. of Limnology.
P. E. Persson.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 211-213, 1988. 1 tab, 6 ref.

Descriptors: *Odor-producing algae, *Odors, *Algae, *Water pollution sources, *Cultures, *Data collections, Organoleptic properties, Microbiological studies.

The IAWPRC Specialist Group on Tastes and Odours collected a list of odorous algal cultures available from culture collections around the world. A request was made to about 100 culture collections, research institutes, and individuals, to obtain information on odorous algal cultures in their depositories. A list of 42 algal strains is presented, supplemented by data on their odor, purity, and where to obtain them. This is not a complete list of the odorous algal cultures actually stored in the culture collections around the world. Some of the great collections indicated that odorous algal strains were included in their collections, but, as their odor had not been studied, no specific information could be given. (Doria-PTT)
W89-06129

DISSOLVED ORGANIC CARBON AND MICROBIAL ACTIVITY IN A HYPERTROPHIC AFRICAN RESERVOIR,
National Inst. for Water Research, Pretoria (South Africa).
For primary bibliographic entry see Field 2H.
W89-06141

DIURNAL VARIATIONS OF CHEMICAL AND PHYSICAL FACTORS IN A RUNNING WATER (SUZE, BERNESE JURA) (TAGESSCHWANKUNGEN CHEMISCHER UND PHYSIKALISCHER FAKTOREN IN EINEM FLIESSGEWAESSER (SCHUESS, BERNER JURA),
Bern Univ. (Switzerland). Zoologisches Inst.
A. Jakob, and P. A. Tschumi.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 607-620, October 1988. 6 fig, 1 tab, 31 ref. (English summary).

Descriptors: *Streamflow, *Water temperature, *Water quality, *Path of pollutants, *Dissolved oxygen, Domestic wastes, Organic wastes, Nitrates, Ammonia, Phosphates, Nitrites, Biochemical oxygen demand, Farm wastes, Hydrogen ion concentration, Hardness, Conductivity, Diurnal distribution, Switzerland, Chemical oxygen demand.

Between dawn and dusk the following chemical and physical parameters were measured every hour in the small river Suze, Bernese Jura: flow, temperature, pH, total hardness, conductivity, dissolved oxygen, BOD5, COD (KMnO4 method), nitrate, nitrite, ammonium and phosphate. The sampling place lay below Courtelary. Measurements were made on 22 days (including two 24 hour sampling periods) between 10th April 1981 and 8th April 1982. The results show that the load of the river is slight and the oxygen supply very good. The regular fluctuations in temperature, pH and dissolved oxygen depend upon solar radiation. Rainfall influences the concentration of the dissolved substances to a large extent--short term after heavy showers and more long term following a high water. Household wastewater induced no regular fluctuations but dairy wastewater may well cause a short though significant increase in the organic load during the morning period. (Author's abstract)
W89-06146

HYDRODYNAMIC AND OIL-SPILL MODELLING FOR THE EAST ASIAN SEAS REGION,
Chulalongkorn Univ., Bangkok (Thailand). Dept. of Marine Science.
A. Siripong.
Ambio AMBOCX, Vol. 17, No. 3, p 183-185, 1988. 25 ref.

Descriptors: *Path of pollutants, *Oil spills, *Model studies, *Southeast Asia, *Computer models, Mathematical models, Wind-driven currents, Coriolis force, Simulation analysis, Monsoons.

Oil pollution of the marine environment is becoming a growing concern in the East Asian Seas region. A prediction model may be very helpful in directing equipment to the most threatened areas. Such a mathematical model has been proposed for the Gulf of Thailand. A computer simulation model of wind-driven current was developed based on the assumption that the current was produced by wind stress, the slope of the water surface, and the Coriolis effect. Six oil-spill models have been published for the East Asian Seas region. There is an urgent need to further develop oil-drift models for the East Asian region - one model to predict the movement of oil in case of oil spills in the region and the other for the statistical computations of probabilities for oil trajectories from selected locations. Spill-trajectory algorithms should be developed for portable microcomputers to allow greater field-support capability than is presently unavailable. (Geiger-PTT)
W89-06170

LIVING ON AN OIL HIGHWAY,
PERTAMINA, Djakarta (Indonesia).
P. L. Coutrier.
Ambio AMBOCX, Vol. 17, No. 3, p 186-188, 1988. 1 tab, 11 ref.

Descriptors: *International agreements, *Oil spills, *Oil pollution, *Indonesia, *Malaysia, *Philippines, *International commissions, *Thailand, *Singa-

pore, Cleanup operations, Water pollution sources, Future planning, Oil tankers, Management planning, Water pollution prevention.

The ASEAN countries, (Indonesia, Malaysia, Philippines, Thailand, and Singapore) jointly and individually, have provided for contingency plans as a means of abating oil spills from shipping activities or oil production facilities. These countries surround two important sea lanes for oil shipping - the Straits of Malacca and Singapore and the straits of Lombok and Macassar. The effectiveness of the plans are difficult to judge because of the absence of major pollution incidents which would require the mobilization of regional contingency plans. The relatively minor spills encountered so far are readily solved by simple arrangements such as the Revolving Fund scheme. The United Nations Environment Program organized a number of intergovernmental and international organizations who provided invaluable support in formulating the East Asian Seas Action Plan and helped identify the major environmental problems of the regions. The adoption of the ASEAN Action Plan an the agreement on supporting measures are major achievements. About fifty national institutions and agencies actively participate in the implementation of agreed program activities, thus providing a relatively broad institutional infrastructure. The ASEAN Contingency Plan is expected to: institute prompt measures for control of oil pollution; mitigate associated environmental effects; coordinate and integrate the action and efforts of the member countries in combating the said discharge of oil; and provide information on operational antipollution facilities and equipment so as to facilitate response operations. (Geiger-PTT)
W89-06171

MERCURY CONTAMINATION IN THE AMAZON: A GOLD RUSH CONSEQUENCE,
Centro de Energia Nuclear na Agricultura, Piracicaba (Brazil).
L. A. Martinelli, J. R. Ferreira, B. R. Forsberg, and R. L. Victoria.
Ambio AMBOCX, Vol. 17, No. 4, p 252-254, 1988. 1 fig, 3 tab, 14 ref.

Descriptors: *Water pollution sources, *Mercury, *Amazon River, *Aquatic plants, *Path of pollutants, Fish, Suspended sediments, Bioaccumulation, Fluvial sediments, Tissue analysis, Water quality standards.

The results of mercury analyses on fish, plants and sediments, collected along the Madeira River (Amazon Basin) in January 1986 are presented. Mercury levels in muscle and eggs from detritivorous, herbivorous, carnivorous, and omnivorous fish ranged from 0.04-3.81 micrograms Hg/g. Several of these values exceeded the safety limit established by the World Health Organization. Mercury concentrations in suspended river sediments, river bedload and floodplain (varzea) sediments ranged from 0.01-0.2 micrograms Hg/g, with little difference between sediment types or among samples collected at different points downstream from Porto Velho. The highest plant values, 0.91 and 1.04 micrograms Hg/g, were obtained for Victoria amazonica and Eichnornia crassipes, respectively, collected in Lago do Macaco. (Author's abstract)
W89-06173

BIOACCUMULATION, DISTRIBUTION AND RETENTION OF NI63(2+) IN THE BROWN TROUT (SALMO TRUTTA),
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Pharmacology and Toxicology.
H. Tjalve, J. Gottofrey, and K. Borg.
Water Research WATRAG, Vol. 22, No. 9, p 1129-1136, September 1988. 2 fig, 3 tab, 18 ref.

Descriptors: *Trout, *Nickel, *Bioaccumulation, *Path of pollutants, Water pollution effects, Biological magnification, Heavy metals, Retention, Toxicity.

Brown trout, Salmo trutta, were exposed to water containing 0.1 or 10 micrograms/L of Ni63(2+) for 1 or 3 weeks. Additional trout were exposed to 0.1 or 10 micrograms/L of Ni63(2+) during 3 weeks followed by a 1- or 3-week period without exposure to the metal. At termination of the experimental periods the uptake and distribution of the Ni63(2+) in the fishes were determined by whole-body autoradiography and liquid scintillation spectrometry. The average whole-fish concentration of Ni63(2+) in the fishes was about 3 times higher than the concentration of Ni63(2+) in the water after 1 week's exposure and about 7-8 times higher than in the water after three weeks' exposure. There was no evidence of saturation of the uptake of the Ni63(2+) at 10 micrograms/L as compared to 0.1 microgram/L. The distribution pattern of the Ni63(2+) within the fishes included an accumulation in the blood, the head and trunk kidney, the gills, the connective tissues, the cerebrospinal fluid and the contents of the stomach and the intestines. After 3 weeks without Ni63(2+)-exposure the average whole-fish concentrations decreased to about 40% of the levels observed immediately after the 3 week exposure. The amounts of Ni63(2+) in the kidneys in relation to other tissues were higher in the groups of fishes exposed to the Ni63(2+) for 3 weeks followed by the 1- or the 3-week period without Ni63(2+) as compared to the fishes killed immediately after the 3-week Ni63(2+)-exposure. The same observation was made for the nervous tissues of the brain and spinal cord, although this uptake in all groups of fishes was rather low. In the gills there was a more rapid decrease in the concentration of Ni63(2+) than the average whole-fish-decrease. The results show that there is a moderate bioaccumulation of nickel by fishes from the water. (Author's abstract)
W89-06187

BIODEGRADATION TEST OF HERBICIDE CNP IN RIVER WATER AND SEDIMENT USING THE MODIFIED RIVER DIE-AWAY METHOD,
Environmental Research Center of Kanagawa Prefecture, Yokohama (Japan).
Y. Fushiwaki, and K. Urano.
Water Research WATRAG, Vol. 22, No. 9, p 1137-1141, September 1988. 8 fig, 1 tab, 6 ref.

Descriptors: *Biodegradation, *Herbicides, *Water pollution, *Fluvial sediments, *Path of pollutants, *Fate of pollutants, Agricultural runoff, Urban runoff, Soil bacteria, Microbial degradation, Bioaccumulation, Seasonal variation, Chlorinated hydrocarbons, Agricultural chemicals.

The biodegradation of the herbicide CNP (2,4,6-trichlorophenyl 4'-nitrophenyl ether) in river waters and sediments was evaluated using a modified river die-away method. Under the test conditions of this method, the biodegradability of CNP in water was different in each region. That is, the biodegradation was rapid in polluted rivers in agricultural and urban areas, but it was slow in clean rivers on the sides of mountains. In addition, seasonal variation in the CNP biodegradation in these test samples was little, though the biodegradation of CNP had a tendency to be slightly higher in June and July, after spraying CNP, in rivers in agricultural areas. It was also suggested that the potential activity of the CNP biodegradable microbes in sediment was almost similar to that in water because of the easy movement of microbes between water and sediment. (Author's abstract)
W89-06188

COMPARATIVE HYDROLYSIS OF SUBSTITUTED UREAS IN A MIXED ALCOHOLIC-WATER SOLUTION,
Boston Univ., MA. Dept. of Chemistry.
A. A. Audu, and A. H. A. Heyn.
Water Research WATRAG, Vol. 22, No. 9, p 1155-1162, September 1988. 7 fig, 6 tab, 8 ref.

Descriptors: *Disinfectants, *Biocides, *Fate of pollutants, *Soaps, *Antimicrobial agents, Bactericides, Hydrolysis, Hydrogen ion concentration, Kinetics, Temperature effects, Ureas.

The carbanilides Triclocarban (TCC, N-(4-chlorophenyl)-N'-(3,4- dichlorophenyl)urea) and Halocarban (HC, N-(4-chlorophenyl)-N'-(4-chloro-3-(trifluoromethyl)phenyl)urea) are used in deodorant soaps because of their bacteriostatic properties. The chemical and physical properties of these agents are important for determining their fate in the environment. In order to relate the rates of hydrolysis of TCC and HC with the structure of these substituted ureas, comparative hydrolysis studies have been made with these compounds, as well as phenylurea, 4-chlorophenylurea, diphenylurea, N-(4-chlorophenyl)-N'-phenylurea and N,N'bis(4-chlorophenylurea. Pseudo first-order rate constants at 25 C for hydrolysis in 0.5 M NaOH (in 77% ethanol-23% water, by vol) varied from .0002 to .0009/day, yielding corresponding half-lives between 2 and 10 yr, respectively. Activation energies have been calculated. For the first two compounds extrapolation to pure water solutions have been made. (Author's abstract)
W89-06191

PARTITIONING OF CHLOROMETHANES BETWEEN AQUEOUS AND SURFACTANT MICELLAR PHASES,
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
K. T. Valsaraj, A. Gupta, L. J. Thibodeaux, and D. P. Harrison.
Water Research WATRAG, Vol. 22, No. 9, p 1173-1183, September 1988. 8 fig, 6 tab, 52 ref.

Descriptors: *Path of pollutants, *Chlorinated hydrocarbons, *Fate of pollutants, *Chloroform, *Surfactants, *Wastewater treatment, Organic compounds, Micelles, Solubility coefficient, Aggregates, Model studies.

The partition constants for three volatile organic chemicals (VOCs), methylene chloride, chloroform and carbon tetrachloride, between aqueous and surfactant micellar phases were determined using an equilibrium partitioning method. The surfactants used were sodium dodecylbenzene sulfonate (DDBS), sodium dodecylsulfate (DDS) and hexadecyltrimethyl ammonium bromide (HTAB). The vapor concentration of the VOCs remained unchanged until the critical micellar concentration (CMC) of the surfactant was reached. Above the CMC the vapor concentration decreased linearly with increasing surfactant concentration in the aqueous phase. The partition constants (Km) were observed to increase with increasing ionic strength of the solution. The partition constants also increased with increasing hydrophobicity of the VOCs. A pseudo-two-phase model was used to determine the Km values and was found to fit the experimental data well. Cationic micelles of HTAB gave larger Km values than anionic micelles of DDS and DBS surfactants. Km values also increased with increasing temperature. From a thermodynamic treatment of the equilibrium process the values of the partition constants for transfer of VOCs from an ideal vapor phase to the micellar phase were calculated. These values were found to fall in between the values for aliphatic hydrocarbons and alcohols. (Author's abstract)
W89-06193

DISTRIBUTION COEFFICIENTS FOR CHEMICAL COMPONENTS OF A COAL-OIL/WATER SYSTEM,
Argonne National Lab., IL. Biological, Environmental, and Medical Research Div.
K. C. Picel, V. C. Stamoudis, and M. S. Simmons.
Water Research WATRAG, Vol. 22, No. 9, p 1189-1199, September 1988. 5 fig, 7 tab, 38 ref. Department of Energy Contract W-31-109-Eng-38.

Descriptors: *Wastewater treatment, *Path of pollutants, *Oil pollution, *Fate of pollutants, *Aromatic compounds, Hydrocarbons, Solubility coefficient, Benzenes, Thermodynamics, Distribution, Oil wastes.

Distribution coefficients (KD) have been shown to be important for predicting the rates and extent of dissolution of organic constituents of coal-oil films and sludges into water and for designing treatment systems for synthetic fuel and coal-coking wastewater streams. Distribution coefficients were measured by equilibrating a coal oil comparative reference material (CRM-1) with water and then separating the oil and water phases. Aqueous phase

concentrations were determined by direct analysis of this phase, while organic phase concentrations were determined from the original oil composition by difference. The log KD values obtained for acidic and basic components were generally <3, while those for the neutral components ranged from 3 to 6. For aromatic hydrocarbons, strong correlations were observed between log KD and log Sw (water solubility), and between log KD and log Kow (octanol/water partition coefficient). Alkylated benzenes had significantly higher distribution coefficients than did unsubstituted aromatics of similar molecular weight. Examination of homologs revealed an increase of 0.307 log KD units per additional carbon atom for polynuclear aromatic hydrocarbons having from 10 to 16 carbons. Alkyl substituent effects determined for various sets of homologs ranged from 0.391 to 0.466 log KD units per -CH2- group added. (Author's abstract)
W89-06195

INFILTRATION AND HYDRAULIC CONDUCTIVITY OF A COMPACTED EARTHEN LINER,
Illinois State Geological Survey Div., Champaign.
K. A. Albrecht, and K. Cartwright.
Ground Water GRWAAR, Vol. 27, No. 1, p 14-19, January-February 1989. 3 fig, 1 tab, 10 ref. EPA Cooperative Agreement EPA-CR-812650-01.

Descriptors: *Water pollution sources, *Hydraulic conductivity, *Infiltration, *Liners, *Wastewater lagoons, Water pollution prevention, Performance evaluation, Earth-water interfaces, Dye releases, Tracers, Infiltrometers, Seepage, Groundwater movement, Soil water.

Infiltration through a small (3 x 9 x 1 m) experimental earthen liner, similar to those used for waste disposal, was evaluated. The liner was constructed using full-size compaction equipment. In situ ponded infiltration rates were measured using 1.5-m diameter sealed, double-ring infiltrometers. An average apparent steady-flux density of 1.5 x 10 to the minus 7th power cm/sec was achieved after 2-3 weeks. Wetting front depths of 7.3 cm and 9.6 cm after 46 days were calculated assuming a Green-Ampt piston flow infiltration system. One of the infiltrometers was ponded with water containing rhodamine dye and after the 46-day infiltration test, a uniform rhodamine dye front was observed at about the 4-cm depth. Sharpness of the dye front suggests that the piston flow assumption is reasonable. Apparent saturated hydraulic conductivity of the liner was estimated from the infiltration data to be no more than 3.6 x 10 to the minus 8th power cm/sec, meeting the present EPA permeability requirement for earthen liners of no more than 1 x 10 to the minus 7th power cm/sec. Transit time for the wetting front to reach the liner bottom at the 0.91-m depth was predicted to be about 3 yr. Seepage flux after liner saturation was estimated at 4.8 x 10 to the minus 8th power cm/sec for a liner ponded with 30 cm of water. (Author's abstract)
W89-06199

SOLUTE TRANSPORT THROUGH SMALL AND LARGE UNSATURATED COLUMNS,
Arizona Univ., Tucson. Dept. of Soil and Water Science.
P. J. Wierenga, and M. T. Van Genuchten.
Ground Water GRWAAR, Vol. 27, No. 1, p 35-42, January-February 1989. 6 fig, 3 tab, 29 ref. NSF Grant BSR-8114466-02, Nuclear Regulatory Commission Contract DE-AC06-76RL0 1830, NRC FIN B2887.

Descriptors: *Leaching, *Path of pollutants, *Solute transport, *Soil contamination, *Tracer studies, *Unsaturated flow, Chlorides, Tritium, Isotope studies, Effluents, Dispersivity, Retention time.

Unsaturated solute transport experiments were conducted using several small (30-cm-long) and one large column (6-m-long) packed with the same sandy soil material. Chloride and tritium were used as tracers for water movement. Soil solution samples were collected as a function of time in the small columns and versus time and depth in the large column. The data were compared with solutions of the classical two-parameter convection-dispersion equation and with solutions of a more elaborated four-parameter transport model that assumes a fraction of the water to be immobile. Fairly symmetrical effluent curves resulted from both the small and large columns, suggesting small transfer coefficients between mobile and immobile regions and small amounts of immobile water. Dispersivity values ranged from 1 cm for the small columns to about 5 cm for the 6-m-long column. Retardation factors for chloride were nearly the same (about 0.8) for both column sizes. Thus, while dispersivity measured in the soil columns did not apply to the large columns, the same retardation factors could be applied to the different scale columns. (Author's abstract)
W89-06202

APPROXIMATE AND ANALYTICAL SOLUTIONS FOR SOLUTE TRANSPORT FROM AN INJECTION WELL INTO A SINGLE FRACTURE,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
C. S. Chen, and S. R. Yates.
Ground Water GRWAAR, Vol. 27, No. 1, p 77-86, January-February 1989. 4 fig, 13 ref, 2 append.

Descriptors: *Solute transport, *Geologic fractures, *Groundwater movement, *Mathematical models, *Computer programs, Stehfest inversion, Airy functions, Porous media, Tracer studies, Radionuclides.

A number of analytical and approximate solutions have been developed to quantify radionuclide transport through fractures in porous formations. Transient and steady state solutions previously developed by Chen have potential usefulness for quantitative study of problems where radioactive material is injected into a fractured formation for disposal or for tracer tests. These solutions also can be used for other purposes. By making use of the Stehfest method, the transient solutions were determined by numerically inverting the solutions to Chen's Model I in the Laplace domain, which involve the transcendental Airy functions. Calculation of the transient solutions is not straightforward. A FORTRAN program and associated documentation is presented for computing the Stehfest inversion and the Airy functions, and the concentration distributions in the fracture and the porous matrix are given for both transient and steady-state cases. A formula determining in the maximum transport distance is given along with data for several hypothetical examples used to illustrate the solutions. (Rochester-PTT)
W89-06207

HEAVY METAL CONCENTRATIONS OF LYMNAEA STAGNALIS L. IN THE ENVIRONS OF LAKE BALATON (HUNGARY),
Balatoni Limnologiai Kutato Intezete, Tihany (Hungary).
For primary bibliographic entry see Field 5A.
W89-06215

CHARACTERIZATION OF POLYETHOXYLATED SURFACTANTS AND THEIR BROMINATED DERIVATIVES FORMED AT THE WATER TREATMENT PLANT OF BARCELONA BY GC/MS AND FAB MASS SPECTROMETRY,
Aigues de Barcelona (Spain).
For primary bibliographic entry see Field 5A.
W89-06216

GENERALIZED SOFT WATER ACIDIFICATION MODEL,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
N. P. Nikolaidis, H. Rajaram, J. L. Schnoor, and K. P. Georgakakos.
Water Resources Research WRERAO, Vol. 24, No. 12, p 1983-1996, December 1988. 3 tab, 6 fig, 40 ref. USEPA cooperative agreement CR-812329-01-5.

Descriptors: *Water pollution sources, *Model studies, *Hydrologic models, *Mathematical models, *Acid rain, Acid streams, Acidic water, Sulfates, Alkalinity, Chlorides, Physicochemical properties, Enhanced trickle-down model, Adirondack Park, New York, Snowmelt.

The enhanced trickle-down (EDT) model has been formulated to include a generalized hydrologic routine that can represent all types of hydrologic systems, mass balances of sulfate, alkalinity and chloride, and major physicochemical and biological processes that affect the acidification of surface water systems. A calibration procedure has been established by decoupling the hydrologic, chloride, sulfate, and alkalinity submodels and optimizing a least squares cost function obtained from simulated and observed data. The system of 20 ordinary differential equations is solved by using a variable time step fourth-order predictor-corrector numerical scheme. Model results are in satisfactory agreement with measured alkalinity concentrations at all times in the simulation. The ETD model is suitable to simulate surface water acidification in the eastern and midwestern United States where sulfate emissions predominate. Its limitations are the lack of a nitrogen transformation submodel in cases where HNO3-NH3 transformations are critical and the lack of a more detailed snowmelt energy budget where early spring events and snowpack processes are important. Calibration of the EDT model for two lakes in the Adirondack Park of New York is illustrated. (White-Reimer-PTT)
W89-06255

INTERPRETATION OF FIELD TRACER TESTS OF A SINGLE FRACTURE USING A TRANSIENT SOLUTE STORAGE MODEL,
National Hydrology Research Inst., Ottawa (Ontario).
For primary bibliographic entry see Field 7B.
W89-06258

FLOW AND TRACER TRANSPORT IN A SINGLE FRACTURE: A STOCHASTIC MODEL AND ITS RELATION TO SOME FIELD OBSERVATIONS,
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 7B.
W89-06259

FLOW AND TRACER TRANSPORT IN FRACTURED MEDIA: A VARIABLE APERTURE CHANNEL MODEL AND ITS PROPERTIES,
California Univ., Berkeley. Earth Sciences Div.
Y. W. Tsang, C. F. Tsang, I. Neretnieks, and L. Moreno.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2049-2060, December 1988. 6 tab, 16 fig, 12 ref. DOE contract DE-AC03-76SF00098.

Descriptors: *Aquifer testing, *Pumping tests, *Path of pollutants, *Groundwater movement, *Fracture permeability, *Fractures, *Tracers, *Model studies, Variable aperture channel model.

Studies on the properties of channels, such as the channel volume, the channel residence time, and the volumetric flow rate are presented along with the calculated dispersion in tracer transport through groups of statistically equivalent channels. The one-dimensional channel model was then applied to breakthrough data from transport in a two-dimensional single fracture in both a forward and an inverse calculation. From this study the following conclusions were drawn: (1) The one-dimensional variable aperture channels in this model are statistically equivalent. They have similar volumes but a range of residence times. (2) A system of these channels comprise the flow conduit between the tracer injection point and the collection point, with the different residence times of the channels giving rise to dispersion. (3) The controlling parameters in this approach are the aperture density distribution and spatial correlation length. (4) For tracer transport between an area of injection and an area of collection where the areas have dimensions significantly larger than the average spacing

between the channels, many channels will be involved and the present model may predict the total tracer breakthrough curve. (White-Reimer-PTT)
W89-06260

SECOND-ORDER KINETIC APPROACH FOR MODELING SOLUTE RETENTION AND TRANSPORT IN SOILS,
Louisiana State Univ., Baton Rouge.
H. M. Selim, and M. C. Amacher.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2061-2075, December 1988. 7 tab, 11 fig, 71 ref.

Descriptors: *Path of pollutants, *Soil dynamics, *Soil contamination, *Chromium, Model studies, Mathematical models, Kinetics, Solutes, Second-order kinetic models, Metals.

A second-order two-site model was proposed to describe Cr kinetic behavior in three soils is demonstrated. Reactions that were postulated to account for the observed kinetic behavior include formation of surface complexes between Cr(VI) and soil, reductive sorption or precipitation of Cr(VI), and internal diffusion. The second-order model was partly successful in predicting Cr miscible displacement results. The necessary model parameters, e.g., total amount of sites, fraction of sites, and rate coefficients, were obtained independently, not by curve fitting. A unique set of batch rate coefficients capable of predicting the breakthrough curves were not obtained due to their strong dependence on input concentrations. When the proposed second-order approach was extended to the mobile-immobile (two-region) concept, little improvement in breakthrough curve predictions was achieved. The failure of the mobile-immobile model was attributed to the estimates for model parameters and/or lack of nonequilibrium conditions in these soils. (White-Reimer-PTT)
W89-06261

ADSORPTION OF TRACE METALS ON ALUMINIUM OXIDE: A SIMULATION OF PROCESSES IN FRESHWATER SYSTEMS BY CLOSE APPROXIMATION TO NATURAL CONDITIONS,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
V. Pavlova, and L. Sigg.
Water Research WATRAG, Vol. 22, No. 12, p 1571-1575, December 1988. 3 fig, 20 ref.

Descriptors: *Acid rain effects, *Water pollution sources, *Trace metals, *Adsorption, *Aluminum, *Precipitation scavenging, *Metal complexes, *Path of pollutants, Simulation, Lakes, Heavy metals.

The interaction of the trace metals Cu, Co, Zn, Ni, Pb and Cd with aluminum hydroxide precipitated in situ from homogeneous solution was studied. Using total concentrations of 0.0001 M Al, 10 to the minus 7 M Zn, Cu, Co, Ni and 10 to the minus 8 M Pb and Cd, a removal of Zn, Cu, Pb, Cd from solution occurred together with Al, while Co and Ni concentrations in solution remained unchanged. The binding of Cu, Pb and Zn, Cd is in agreement with the effect predicted by using published (resp. evaluated for Zn and Cd), values for stability constants of surface complexes on preformed Al2O3-suspension. The different behavior of these elements and of Co and Ni is expected from the hydrolysis and adsorption tendencies. The experimental conditions correspond to natural conditions in lake waters, where due to the pH-dependent solubility of aluminum hydroxide, in situ precipitation may occur and cause the scavenging of trace elements. (Author's abstract)
W89-06305

MEASUREMENTS OF THE DISPERSION OF LIQUID INDUSTRIAL WASTE DISCHARGED INTO THE WAKE OF A DUMPING VESSEL,
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
For primary bibliographic entry see Field 5E.
W89-06306

CAMPYLOBACTERS IN MAN AND THE ENVIRONMENT IN HULL AND EAST YORKSHIRE,
Public Health Lab. Service, Hull (England). Hull Royal Infirmary.
For primary bibliographic entry see Field 5A.
W89-06310

SELENIUM ACCUMULATION IN BENTHIC BIVALVES AND FINE SEDIMENTS OF SAN FRANCISCO BAY, THE SACRAMENTO-SAN JOAQUIN DELTA, AND SELECTED TRIBUTARIES,
Geological Survey, Menlo Park, CA.
C. Johns, S. N. Luoma, and V. Elrod.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 27, No. 4, p 381-396, October 1988. 6 fig, 3 tab, 58 ref.

Descriptors: *Selenium, *Bioaccumulation, *Fluvial sediments, *Clams, Benthic fauna, San Francisco Bay, Path of pollutants, Agricultural runoff, Heavy metals, Mollusks.

Spatial distributions of selenium were determined in fine-grained, oxidized, surface sediments and in two benthic bivalves (Corbicula sp., a suspension-feeding freshwater clam, and Macoma balthica, a deposit-feeding brackish-water clam) within San Francisco Bay, the San Joaquin River and three river systems unlikely to be subject to selenium inputs. Biologically available selenium enters the middle reaches of the San Joaquin River from agricultural runoff. However, selenium concentrations in sediments and Corbicula in the lower San Joaquin, upstream from San Francisco Bay, were not significantly different from concentrations in rivers with no known selenium inputs. Biologically available selenium did not appear to enter the northernmost reach of San Francisco Bay from the San Joaquin River in levels which could measurably influence bioaccumulation by Corbicula. Selenium concentrations in Corbicula were enriched in the northernmost reach of San Francisco Bay compared with the rivers, but several lines of evidence suggested that local inputs (perhaps from urban/industrial waste discharges) were the most important sources. Selenium concentrations in Macoma balthica were also elevated at one station in the northern reach of the Bay and at one station in the extreme South Bay. However, no enrichment was evident at two other stations, suggesting a lack of bay-wide contamination. No significant correlation between selenium and mercury concentrations in Corbicula tissues was observed. (Author's abstract)
W89-06313

BIOGEOCHEMICAL CONTROL OF THE SUMMER DISTRIBUTION AND SPECIATION OF ARSENIC IN THE TAMAR ESTUARY,
Southampton Univ. (England). Dept. of Chemistry.
A. G. Howard, S. C. Apte, S. D. W. Comber, and R. J. Morris.
Estuarine, Coastal and Shelf Science ECSSD3, Vol. 27, No. 4, p 427-443, October 1988. 9 fig, 1 tab, 38 ref.

Descriptors: *Biotransformation, *Arsenic, *Path of pollutants, *Estuarine environment, *Speciation, Biochemistry, Geochemistry, England, Phytoplankton, Spatial distribution, Heavy metals.

Measurements of the distribution of dissolved inorganic and methylated arsenic in the Tamar estuary (southwest England) over a number of summers have illustrated the consistent non-conservative behavior of inorganic arsenic and extensive bioutilization. The concentration difference between the estuary freshwater endmember, which contains between 2.7 and 8.8 microg of dissolved arsenic and the seawater endmember (c. 1 microg of dissolved arsenic) is not reflected in the distribution of dissolved arsenic in the estuary, with dissolved inorganic arsenic being particularly elevated in the higher salinity (tidal mudflat) region. Short-term laboratory mixing of the river and seawater endmembers (unfiltered and filtered) shows no evidence of either salinity-induced release of arsenic from the suspended sediments or the removal of arsenic from the dissolved phase. Bioutilization of the element during the warmer months results in the release of dissolved monomethylarsenic and dimethylarsenic and these have reached maximum concentrations of 0.46 and 1.27 microg As/L, respectively, in the estuary mouth. The distribution of these species was not correlated to the distribution of chlorophyll-a (phytoplankton biomass). A highly productive community of the freshwater diatom Cyclotella atomus in the brackish water end of the estuary had little impact on arsenic speciation, whereas, extensive arsenic biomethylation was observed in the seaward end of the estuary. This highlights differences in arsenic metabolism between marine and freshwater phytoplankton living at similar arsenic and phosphate concentrations, and suggests that biomethylation in the Tamar estuary is governed by marine biological processes. (Author's abstract)
W89-06316

ACID MINE DRAINAGE AT CAPTAINS FLAT, NEW SOUTH WALES,
Bureau of Mineral Resources, Geology and Geophysics, Canberra (Australia).
G. Jacobson, and G. F. Sparksman.
BMR Journal of Australian Geology and Geophysics BJAGDT, Vol. 10, No. 4, p 391-393, June 1988. 4 fig, 1 tab, 10 ref.

Descriptors: *Acid mine drainage, *Australia, *Zinc, *Water pollution control, *Stream pollution, Water pollution sources, Rehabilitation, Mine wastes, Heavy metals, Path of pollutants, Mine drainage.

The zinc-lead-copper mine at Captains Flat, New South Wales, was worked between 1882 and 1962, producing about 4 million tons of ore. After closure of the mine, the underground workings filled with water, which overflowed into the Molonglo River. Eventually, the tailings dumps were stabilized and vegetated at a cost of several million dollars. The year 1982 was one of the driest years on record in this region, and flows in the Molonglo River were low throughout the year. Acid drainage from the abandoned base-metals mine is the main contributor of zinc to the Molonglo River in low flow conditions. In 1982, zinc was detectable in the river for 50 km downstream of Captains Flat. Rehabilitation works at the mine site have effectively stabilized tailings dumps, and neutralized them as a source of major pollution. However, maintenance of the existing rehabilitation works at Captains Flat will be necessary for some time to come, and reduction of the pollution caused by acid mine drainage could require the construction of additional treatment works. (Author's abstract)
W89-06326

ISOLATION OF ENTEROPATHOGENIC AND ENTEROTOXIGENIC ESCHERICHIA COLI FROM THE DAL LAKE WATER OF KASHMIR,
Sher-i-Kashmir Inst. of Medical Sciences, Srinagar (India). Dept. of Microbiology.
K. Koul, and B. R. Panhotra.
Letters in Applied Microbiology LAMIE7, Vol. 7, No. 4, p 109-111, October 1988. 1 tab, 11 ref.

Descriptors: *Bacterial analysis, *Path of pollutants, *Lakes, *Escherischia coli, *Pathogens, Sewage bacteria, Public health, Enteric bacteria, Dal Lake, India, Coliforms, Water pollution sources.

Escherichia coli were present in 89 of 120 water samples collected from the waters of Dal Lake, India, during July to December 1986. The viable counts ranged from 100 to 3000 cfu per 100 ml water. Eighteen strains of enteropathogenic serotypes isolated. Of these, 12 strains were positive for heat-labile enterotoxin. Some of the strains were also positive for colonization factor antigen I or II. During the same period enterotoxigenic strains of E. coli were isolated from 33.8% and enteropathogenic strains from 5.2% of the fecal samples of local children with diarrhea. These findings indi-

cate that the source of bacterial pollution was sewage from houseboats and the surrounding area. (Cassar-PTT)
W89-06331

LEAD POISONING IN SWANS AND SOURCES OF CONTAMINATION IN IRELAND,
University Coll., Cork (Ireland). Dept. of Zoology.
For primary bibliographic entry see Field 5C.
W89-06332

WORMS, WELLS AND WATER IN WESTERN MADAGASCAR,
Southampton Univ. (England).
For primary bibliographic entry see Field 6G.
W89-06333

GREAT LAKE MANITOULIN: GEORGIAN BAY AND THE NORTH CHANNEL,
Canada Centre for Inland Waters, Burlington (Ontario).
P. G. Sly, and M. Munawar.
Hydrobiologia HYDRB8, Vol. 163, p 1-19, June 20, 1988. 6 fig, 43 ref.

Descriptors: *Fisheries, *Water quality, *Geology, *History, *Lakes, *Limnology, *Lake Huron, *Georgian Bay, North Channel, Vegetation, Transportation, Ships, Lumber, Logging, Mineral industry, Industrial plants, Recreation, Water circulation, Stratification, Lake Superior, Lake Huron, Nutrients, Phosphorus, Phytoplankton, Chlorophyll, Algae, Productivity, Primary productivity, Zooplankton, Invertebrates, Benthos, Lake fisheries, Fish populations, Path of pollutants, Great Lakes, Regional development.

This paper presents an overview of background information about Georgian Bay and the North Channel of Lake Huron. Sometimes described as a sixth Great Lake and originally named Lake Manitoulin in 1815, Georgian Bay was later defined as part of Lake Huron. Water from Lake Superior passes through the North Channel into Lake Huron. Details on physical characteristics, geology, soils, vegetation, climate, exploration, settlement and development, limnology, and fisheries are given. European exploration for the fur trade touched the region in 1610. Subsequently, trading posts, farming, lumbering, and mineral industry development produced a need for shipping, lighthouses, and lake ports. Water from Lake Superior flows into Lakes Huron and Michigan, mostly through the North Channel. Wind forcing is responsible for most of the water exchange between Georgian Bay and the Channel and between Georgian Bay and Lake Huron. Residence and flushing times for the Channel are 1.8 and 2.0 years, respectively; for the Bay 6.9 and 8.5 years, respectively. Lakewide stratification begins near the end of June. Water temperature extremes are 20C with maximum in late August and minimum in February, when ice cover reaches 85-90%. Water chemistry is dominated by Lake Superior inflow and modified by tributary contributions. The effects of urban loadings are seen near Sault Ste. Marie. Georgian Bay is considered oligotrophic; with some local areas of eutrophication. Results are given for studies on chlorohpyll a, primary productivity, phytoplankton biomass, benthic macroalgae, zooplankton, and benthos. Commercial fishing began in the early 1830s. Since then, lake trout have been nearly eliminated because of overfishing and the exotic species. Burdens of contaminants in the fish have been decreasing since 1979, reached a minimum in 1983, and have increased since then. (See W89-06336 thru W89-06348) (Cassar-PTT)
W89-06335

PHYTOPLANKTON AND PHOSPHORUS IN SOUTHERN GEORGIAN BAY, 1973-1982, AND IMPLICATIONS FOR PHOSPHORUS LOADING CONTROLS,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
K. H. Nicholls, G. W. Robinson, R. Taylor, and E. C. Carney.
Hydrobiologia HYDRB8, Vol. 163, p 85-93, June 20, 1988. 9 fig, 1 tab, 18 ref.

Descriptors: *Water pollution control, *Water pollution effects, *Eutrophication, *Lakes, *Limnology, *Georgian Bay, *Lake Huron, *Phosphorus, *Phytoplankton, *Nutrients, Water pollution sources, Great Lakes, Severn Sound, Nottawasaga Bay, Penetang Bay, Wastewater pollution, Algae, Trophic level, Path of pollutants, Enrichment, Bays, Biomass, Bioindicators, Water quality control.

The phytoplankton and nutrient status of the embayments between Penetanguishene and Waubaushene in southern Georgian Bay (Severn Sound) were examined during the ice-free periods of 1973-1982 because the area showed symptoms of excessive nutrient enrichment. Four wastewater treatment plants currently discharge to the area, another is under construction and a sixth plant has been proposed. Except for Penetang Bay, the area is well-mixed by prevailing winds but is somewhat isolated from the main part of Georgian Bay. Average phytoplankton biomasses throughout the area were 10 to 20 times higher than values from adjacent Nottawasaga Bay where, during 1980, total phytoplankton biomass ranged between 0.15 and 0.25 cu mm per liter. Total phosphorus concentrations were highest in Penetang Bay, ranging between 30 and 49 micrograms P per liter (May to September means) over the ten-year period. Phosphorus concentrations in Nottawasaga Bay averaged 4 to 6 micrograms P per liter, and no significant differences were detected among the sampling stations. However, phytoplankton densities at stations near urban centers and river inflows were significantly higher than at more remote offshore sites, attesting to the use of phytoplankton as a sensitive measure of trophic status in Georgian Bay. Although improvement of Severn Sound water quality to a level comparable that presently existing in Nottawasaga Bay may never be practical, steps are being taken to control high industrial phosphorus loading and to lessen bypassing of sewage treatment facilities previously hydraulically overloaded during periods of heavy runoff. These measures, along with an evaluation of other major sources of nutrients to Severn Sound, should enable a refinement of the nutrient management program for Severn Sound and some improvement in trophic status. (See also W89-06335) (Author's abstract)
W89-06340

SEDIMENTARY DIATOM ASSEMBLAGES AND THEIR UTILITY IN COMPUTING DIATOM-INFERRED PH IN SUDBURY ONTARIO LAKES,
Trent Univ., Peterborough (Ontario). Trent Aquatic Research Centre.
For primary bibliographic entry see Field 2H.
W89-06349

HYDROGEN SULFIDE PRODUCTION IN BOTTOM SEDIMENTS IN THE NORTHERN AND SOUTHERN LAKE BIWA,
Kyoto Univ., Otsu (Japan). Otsu Hydrobiological Station.
H. Maeda, and A. Kawai.
Nippon Suisan Gakkaishi NSUGAF, Vol. 54, No. 9, p 1623-1633, September 1988. 8 fig, 3 tab, 31 ref.

Descriptors: *Lake Biwa, *Japan, *Hydrogen sulfide, *Bottom sediments, *Lakes, *Oxygen depletion, *Eutrophication, Organic acids, Bacteria, Water pollution, Radioactive tracers, Sulfates, Biotransformation.

The condition of hydrogen sulfide production in bottom sediments was investigated in the mesotrophic Northern and eutrophic Southern Lake Biwa by using radioactive S35 sulfate. The concentration of total sulfides in the surface sediment was much higher in the Northern Lake than in the Southern Lake. This higher concentration was considered to be the result of the activity of sulfate reduction (20 nmol/cu cm/day), which was 5 times higher than that in the Southern Lake. The activity of sulfate reduction by bacteria was not necessarily correlated with the number of sulfate-reducing bacteria in Lake Biwa. Lower redox potential and higher concentration of organic acids promoted higher sulfide production in the Northern Lake than in the Southern Lake. The organic acids that are utilized as the electron donor in sulfate reduction were butyrate and formate in the lake sediment. Although acetate was present in high amount, it was not utilized. (Author's abstract)
W89-06370

TRACE METAL CONCENTRATIONS IN SOME KASHMIR HIMALAYAN LAKES,
Kashmir Univ., Srinagar (India). Centre of Research for Development.
V. K. Koul, D. P. Zutshi, and K. P. Dubey.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 237-245, June 1988. 4 fig, 3 tab, 18 ref.

Descriptors: *Lakes, *Mountain lakes, *Trace elements, *Heavy metals, *Water pollution, Toxicity, Himalayas, Lead, Manganese, Copper, Zinc, Cobalt.

The concentrations of trace elements (Pb, Mn, Cu, Zn and Co) were measured in three Kashmir Himalayan Lakes. Cadmium, Ag, and Hg were not detected. In addition physicochemical parameters of the lakes were analyzed to assess the water quality. Trigam and Tilwan lakes are more enriched than Khanpur lake. Comparisons of trace metal levels with EPA standards show that Mn (1., 2.72, and 4.24 mg/L) and Pb (0.246, 0.478, and 0.425 mg/L) concentrations in Lakes Khanpur, Trigam, and Tilwan, respectively are well above the permissible levels. The greater anthropogenic effects on Trigam and Tilwan lakes and their nondrainage type of basins account for the high trophic levels. The high concentration of trace metals makes these waters unfit for human use. (Brock-PTT)
W89-06386

WATERSHED VS IN-LAKE ALKALINITY GENERATION: A COMPARISON OF RATES USING INPUT-OUTPUT STUDIES,
NSI Technology Services Corp., Corvallis, OR.
P. W. Shaffer, R. P. Hooper, K. N. Eshleman, and M. R. Church.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 263-273, June 1988. 3 fig, 41 ref.

Descriptors: *Watersheds, *Lakes, *Acid rain, *Water pollution sources, *Alkalinity, Chemical properties, Drainage systems, Acid deposition.

As a means of assessing the relative contributions of watershed (terrestrial) and in-lake processes to overall lake/watershed alkalinity production rates for watersheds and low alkalinity lakes were compiled from the literature and compared. Based on net alkalinity production data, derived using wet or bulk deposition data, mean and median alkalinity production for 20 watersheds in North America and Europe were 89 and 69 meq/sq m/yr (range 20 to 235 meq/sq m/yr). For a subset of 10 watersheds with dry deposition data, terrestrial alkalinity production neutralized an additional 35 meq/sq m/yr of acidic deposition. For 11 lakes, mean and median in-lake alkalinity generation were 99 and 88 meq/sq m/yr (range 22 to 240 meq/sq m/yr). Analysis of data indicates that for low alkalinity systems, areal alkalinity production rates for watersheds and lakes are approximately equal. Watershed area to lake area ratio can be used as a convenient estimator of the relative importance of watershed and in-lake sources of alkalinity for drainage lake systems. For precipitation-dominated seepage lakes and other systems where hydrology limits soil-water contact, hydrologic flow paths and residence times can be of overriding importance in determining alkalinity sources. For regions dominated by drainage lakes with high watershed area to lake area ratios (such as the Northeastern U.S.), however, alkalinity budgets are dominated by watershed processes. Omission of in-lake alkalinity consideration for most lakes in such regions would have little impact on computed alkalinity budgets or on predicted response to changes in acidic deposition loadings. (Author's abstract)
W89-06387

ATMOSPHERIC DEPOSITION EFFECTS ON THE CHEMISTRY OF A STREAM IN NORTHEASTERN GEORGIA,

Geological Survey, Doraville, GA. Water Resources Div.
G. R. Buell, and N. E. Peters.

Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 275-291, June 1988. 8 fig, 3 tab, 30 ref.

Descriptors: *Acid rain, *Water pollution sources, *Water pollution effects, *Stream pollution, Chemical properties, Acid deposition, Georgia, Storm runoff, Sulfates, Nitrates, Carbonates, Surface-groundwater relations.

The quantity and quality of precipitation and streamwater were measured from August 1985 through September 1986 in the Brier Creek watershed, a 440-ha drainage in the Southern Blue Ridge Province of northeastern Georgia, to determine stream sensitivity to acidic deposition. Precipitation samples collected at 2 sites had a volume-weighted average pH of 4.40 whereas stream samples collected near the mouth of Brier Creek had a discharge-weighted average pH of 6.70. Computed solute fluxes through the watershed and observed changes in streamwater chemistry during storm-flow suggest that cation exchange, mineral weathering, SO4(2-) adsorption by the soil, and groundwater discharge to the stream are probable factors affecting neutralizing of precipitation acidity. Net solute fluxes for the watershed indicate that, of the precipitation input, > 99% of the H(+), 93% of the NH(4)(+) and NO3(-), and 77% of the SO4(2-) were retained. Sources within the watershed yielded base cations, Cl(-), and HCO3(-) and accounted for 84, 47, and 100% of the net transport, respectively. Although streamwater SO4(2-) and NO3(-) concentrations increased during stormflow, peak concentrations of these anions were much less than average concentrations in the precipitation. This suggests retention of these solutes occurs even when water residence time is short. (Author's abstract)
W89-06388

AIRBORNE TRANSPORT OF SULPHUR: IMPACTS ON CHEMICAL COMPOSITION OF RIVERS ON NORTH SHORE OF THE ST. LAWRENCE RIVER (QUEBEC),

Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
M. Lachance, D. Brouard, and G. Walsh.

Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 311-322, June 1988. 3 fig, 2 tab, 33 ref.

Descriptors: *Acid rain, *Water pollution sources, *Rivers, *Air pollution effects, *Sulfur, *Sulfates, Airborne transport, Hydrogen ion concentration, Chemical properties, Canada, St. Lawrence River, Organic acids.

The St. Lawrence North Shore region (Quebec) is subject to acid precipitation entailing sulfate deposition (17 to 22 kg SO4(2-)/ha/yr) which poses a threat to sensitive aquatic ecosystems. Physicochemical surveys conducted in 1982-1983 revealed the extreme sensitivity of the region owing to weak mineralization of the waters (mean alkalinity of 55 microequivalents/L and conductivity of 17 microsiemens/cm). Calculation of the annual loads of S discharged from 21 rivers throughout the region shows atmospheric deposition as the principal source of sulfate. A decreasing west-east gradient in the concentration is interpreted in terms of the impact of long-range airborne transport, although certain local sources of S emission are not to be overlooked. Analysis of the seasonal variation in the sulfate load balance, conducted in a small drainage basin (40 sq km), revealed that the sulfate anion plays a part in lowering the water pH in spring. The spring pH depression is apparently intensified by an additional input of sulfate stemming from the release of this element subsequent to accumulation in the drainage basin during summer and fall. Organic acids play a measurable role in the chemical equilibrium of surface waters in the region, particularly in the eastern sector where there is less S fallout. Low pH levels in this sector (5.5 to 6.0) point to some degree of organic acidification. (Author's abstract)
W89-06390

TEMPORAL AND SPATIAL TRENDS IN METAL LOADS TO SEDIMENTS OF LAKE SIMCOE, ONTARIO,

Department of Fisheries and Oceans, Owen Sound (Ontario). Great Lakes Fisheries Research Branch.
M. G. Johnson, and K. H. Nicholls.

Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 337-354, June 1988. 3 fig, 4 tab, 28 ref.

Descriptors: *Air pollution effects, *Lake Simcoe, *Lakes, *Water pollution sources, *Lake sediments, *Heavy metals, Temporal distribution, Spatial distribution, Chemical properties, Canada, Lead, Copper, Nickel, Zinc, Cadmium, Chromium, Marshes, Erosion, Sedimentation rates.

Metal loads to sediments of Lake Simcoe were partitioned into three components, which were attributable to natural background, accelerated erosion, and point + atmospheric sources. These loads were calculated over time using metal concentration profiles together with pre-settlement sedimentation rates based on sonar and time-variable sedimentation rates based on Po210 profiles in cores. Concentrations of metals significantly higher than pre-settlement concentrations were observed in all cores in the case of Pb, back to 80 yr BP on average, and in at least 75% of cores, back to 60 yr BP for Cd and Zn and 30 to 45 yr BP for Cu, Ni, and Cr. Total metal loads increased 3x for Cu and Ni, 4x for Zn and Cr, 11x for Cd and nearly 20x for Pb from pre-1800 to 0 to 10 yr BP. About 90% of the anthropogenic loads of Pb and Cd, and 60 to 70% of the anthropogenic Cu, Ni, Zn, and Cr, are from point + atmospheric sources, the balance being from increased erosion. The direct atmospheric input of Cd is relatively high, approximately 77% of point + atmospheric inputs, while inputs of Cr and Ni are low at 1% and 9%, and inputs of Cu, Zn, and Pb are intermediate at 20 to 40% of point + atmospheric inputs. Two significant findings on spatial distribution of metals were the large increases in metal loads to Cook Bay following the drainage of 33 sq km of marshes for agricultural use and the widespread dispersal of Cr from point source(s) in Kempenfelt Bay. (Author's abstract)
W89-06391

DIFFERENCES BETWEEN NEW ENGLAND COASTAL FOG AND MOUNTAIN CLOUD WATER CHEMISTRY,

Appalachian Mountain Club, Gorham, NH. Research Dept.
K. D. Kimball, R. Jagels, G. A. Gordon, K. C. Weathers, and J. Carlisle.

Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 383-393, June 1988. 3 fig, 2 tab, 29 ref.

Descriptors: *Water pollution sources, *Acid rain, *Cloud liquid water, *Fog, *Air pollution, Coastal fog, Mountain clouds, Chemical properties, Hydrogen ion concentration, New England, Ozone, Nitrates, Urban areas.

Major inorganic ions and pH were analyzed from mountain cloud and coastal fog water event samples from New Hampshire and Maine. Based on marine corrected values, the medians for coastal fog were still up to 3 times higher in ionic concentrations and lower in pH, compared with mountain clouds. Of the acidic constituents, nitrate concentrations were considerably higher in coastal fogs, which correlates with higher concentrations of O3 measured along the New England coast. It is hypothesized that meteorological conditions permit air pollutants emitted in the northeastern U.S. urban corridor to move relatively intact across the Gulf of Maine and to interact with the coastal fogs, which results in differences in the chemistry of coastal fogs and mountain clouds. (Author's abstract)
W89-06395

LAND USE CONSIDERATIONS IN REDUCING OIL AND GREASE IN URBAN STORMWATER RUNOFF,

Bowling Green State Univ., OH.
For primary bibliographic entry see Field 5G.
W89-06401

MODEL FOR IRREVERSIBLE ADSORPTION HYSTERESIS,

Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil and Ocean Engineering.
D. A. Vaccari, and M. Kaouris.

Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 797-822, 1988. 1 tab, 6 fig, 13 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Water pollution prevention, *Groundwater pollution, *Soil absorption capacity, *Hysteresis, *Model studies, Mathematical models, Drinking water, Phenols, Organic compounds, Adsorption, Soil dynamics, Soil water.

A model to describe irreversible adsorption hysteresis has been proposed and validated. The model describes solute molecules as irreversibly adsorbed at one set of sites and weakly adsorbed reversibly without hysteresis at the other site. The combination of these two effects produces irreversible hysteresis behavior. The model was validated using adsorption/desorption data for phenol adsorbed on flyash, and using data from the literature for the adsorption of picloram on norge loam. The model has implications for risk assessment or remedial actions for hazardous waste sites. Risk assessment may be affected either positively or negatively, depending on whether the primary mode of exposure is by contact with soil particles or by drinking the groundwater. In the first case, the soil would retain the contamination even if exposed to substantial washing and increase the danger of soil contact. If drinking water contamination is the highest priority, then the effect of irreversible adsorption is protective, since soil would be removing the contamination from the water. (White-Reimer-PTT)
W89-06411

INFLUENCE OF SUSPENDED PARTICULATE MATTER REGIME ON THE HEAVY METAL POLLUTION OF THE TIDAL RIVER ELBE AT HAMBURG,

Umweltbundesamt, Berlin (Germany, F.R.).
U. Irmer, H. Knauth, and K. Weiler.

Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 236-240, December 1988. 1 tab, 6 fig, 23 ref. English summary.

Descriptors: *Path of pollutants, *Monitoring, *Tidal rivers, *Elbe River, *Germany, *Heavy metals, *Trace metals, *Metals, *Suspended solids, Mercury, Cadmium, Lead, Copper, Hamburg, Seston, Seasonal variation, Water sampling.

In monitoring programs heavy metal contents of flowing water are usually determined as total concentrations. Particularly in tidal rivers which are characterized by conspicuous changes of suspended particulate matter, an assessment of the pollution of different areas and in time series could only be achieved by separate analysis of 'dissolved' and seston bound heavy metal concentrations. Analysis of the heavy metal of suspended particulate matter showed that the monitoring strategy used is suitable to prove the influence of the suspended particulate matter regime on the area and the time (season) dependent specific variability of heavy metal pollution in the widely branched tidal Elbe River at Hamburg. (Author's abstract)
W89-06417

APPROACHES TO RAPID AND FAR-REACHING HYDROLOGIC PROCESSES IN THE VADOSE ZONE,

Rutgers - The State Univ., New Brunswick, NJ. Dept. of Soils and Crops.
For primary bibliographic entry see Field 2F.
W89-06421

AGGREGATED MIXING ZONE MODEL OF SOLUTE TRANSPORT THROUGH POROUS MEDIA,

Lancaster Univ. (England). Dept. of Environmental Sciences.
K. J. Beven, and P. C. Young.

Journal of Contaminant Hydrology JCOHE6, Vol.

3, No. 2-4, p 129-143, December 1988. 4 fig, 2 tab, 27 ref.

Descriptors: *Path of pollutants, *Porous media, *Solute transport, *Soil water, *Mathematical models, Simulation, Aggregated Mixing Zone Model.

A new investigative modelling procedure for transport of solutes through undisturbed soil is described. The Aggregated Mixing Zone (AMZ) model makes minimal a priori assumptions about the nature of the flow process in the sample. Both model structure and parameter values are determined from observed breakthrough curve data using advanced recursive instrumental variable techniques. The AMZ approach is similar to the Jury transfer function model approach, but allows a considerable degree of flexibility in model structure within a consistent framework. The AMZ model generally yields very good fits to the observed breakthrough curves including curves that are not consistent with the traditional convective-dispersion model. Examples are given of models for breakthrough curves showing bimodal impulse response functions. (Author's abstract)
W89-06422

MODELING TRACER DIFFUSION IN FRACTURED AND UNFRACTURED, UNSATURATED, POROUS MEDIA,
Los Alamos National Lab., NM.
K. H. Birdsell, L. F. Brown, A. E. Norris, G. A. Cederberg, and B. J. Travis.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 145-170, December 1988. 15 fig, 4 tab, 15 ref.

Descriptors: *Soil water movement, *Path of pollutants, *Radioactive waste disposal, *Porous media, *Tracers, *Solute transport, *Mathematical models, Diffusion, Simulation, Diffusion coefficient, Porosity, Advection, Saturation, Geologic fractures, Boreholes, Yucca Mountain, Nevada, Calico Hills Tuff, Topopah Spring Member.

A proposed tracer diffusion test for the Exploratory Shaft Facility at Yucca Mountain, NV, was modeled. For the proposed test, a solution containing conservative tracers will be introduced into a borehole in the geologic medium of interest. The tracers will diffuse and advect from the saturated source region into the unsaturated matrix in the surrounding tuff. After some time, the borehole is to be overcored, and tracer concentrations in the fluid will be measured in the core as a function of distance from emplacement. The data will be used to evaluate diffusive behavior and to derive effective diffusion coefficients for the tracers in the specific tuff. Numerical simulations were used to study the effects of effective diffusion coefficient, porosity, saturation, and fracturing on tracer transport. Results are reported for numerical simulations of tests in the Topopah Spring Member and the Tuff of Calico Hills, which have significantly different porosities and saturations. The simulations make the following predictions: The spread of tracer during the test will be sensitive to the effective diffusion coefficient of the tracer. Tracer will diffuse farther in the Topopah Spring Member than in the Tuff of Calico Hills because of the former's lower porosity and saturation. Tracer transport by advection into the Topopah Spring Member will be greater than that into the Tuff of Calico Hills because of capillary effects. While advection will be a significant mechanism for tracer penetration into the Topopah Spring tuff, it will be less significant for tracer penetration into the Calico Hills tuff. The proximity of a single vertical fracture to the source region determines its effect on tracer transport, especially if the fracture diverts fluid flowing from the source region into the matrix. (Author's abstract)
W89-06423

SUBSURFACE STORMFLOWS IN THE HIGHLY PERMEABLE FORESTED WATERSHEDS OF SOUTHWESTERN BRITISH COLUMBIA,
British Columbia Ministry of Forests and Lands, Kamloops. Research Section.
For primary bibliographic entry see Field 2G.
W89-06424

CONTRIBUTIONS OF MACROPOROSITY TO INFILTRATION INTO A CONTINUOUS CORN NO-TILLED WATERSHED: IMPLICATIONS FOR CONTAMINANT MOVEMENT,
Agricultural Research Service, Coshocton, OH. North Appalachian Experimental Watershed.
W. M. Edwards, M. J. Shipitalo, and L. D. Norton.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 193-205, December 1988. 6 fig, 1 tab, 25 ref.

Descriptors: *Agricultural Watersheds, *Path of pollutants, *Agricultural chemicals, *Groundwater pollution, *Cropland, *Soil porosity, Infiltration, Percolation, Rainfall, Surface runoff, Corn, Tillage, Earthworm burrows, Lime, Hydrogen ion concentration, Ohio.

Rainfall and runoff were measured for many years on small watersheds on 10-15% slopes in east-central Ohio. Surface runoff from watersheds used for corn (Zea mays) production was high with conventional tillage and very low with no-tillage. A 50-year storm produced 15 times more runoff from a plowed watershed than from a mulch-covered no-till watershed. Reduced runoff from the no-till surface resulted in increased percolation and enhanced the potential for transport of agricultural chemicals to the groundwater. The mulched surface of the no-till watershed also created a favorable environment for the deep burrowing earthworm, Lumbricus terrestris, whose burrows can transmit water rapidly downward through the soil profile, thus contributing to the high infiltration rates. Open biopores and smaller structural pores were counted and measured to characterize the major flow paths of water movement in the no-till soil. Photos of horizontal surfaces at 2.5-, 7.5-, 15-, and 30-cm depths and vertical faces of impregnated samples from the 1- and 5-cm depths were evaluated by image analysis. Numbers of pores was inversely proportional to the pore diameter; however, pores in the 0.05-1.0 mm diameter range accounted for less porosity than did those in the 1.0-5.0 mm range. The large pores were nearly vertical earthworm burrows and were continuously open from near the surface to the bedrock. Surface applications of lime increased subsoil pH in the no-till watershed but had little effect below the plow sole in the tilled watershed, suggesting that rapid movement of water in large pores can enhance chemical migration into the subsoil. (Author's abstract)
W89-06425

WETTING FRONT INSTABILITY AS A RAPID AND FAR-REACHING HYDROLOGIC PROCESS IN THE VADOSE ZONE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W89-06426

KINEMATIC WAVE APPROXIMATION TO SOLUTE TRANSPORT ALONG PREFERRED FLOW PATHS IN SOILS,
Camp, Dresser and McKee, Inc., Boston, MA.
B. S. Levy, and P. F. Germann.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 263-276, December 1988. 5 fig, 4 tab, 26 ref. USEPA Assistance Agreement R811528-01-0.

Descriptors: *Path of pollutants, *Soil water, *Solute transport, *Forest soils, *Kinematic wave theory, *Model studies, Infiltration, Drainage.

A routing procedure is introduced which accounts for the loss of a conservative solute tracer from preferred paths during macropore flow. Water flow is treated as a series of kinematic waves from which the tracer is lost due to mixing with previously stored soil water, and an expression for solute loss is added to a previously developed model. The model parameters were estimated through experiments at three different input rates applied to a column of a macroporous forest soil. The results of seven experimental runs indicate that solute losses are consistently highest at the early stages of infiltration and drainage flow. An empirical relationship is proposed which links the frequency distribution of the flow parameter with that for solute loss from the preferred path during transient water flow and solute transport. (Author's abstract)
W89-06429

PRELIMINARY CAPILLARY HYSTERESIS SIMULATIONS IN FRACTURED ROCKS, YUCCA MOUNTAIN, NEVADA,
Lawrence Berkeley Lab., CA. Earth Sciences Div.
For primary bibliographic entry see Field 2F.
W89-06430

SOURCE AREAS CONTRIBUTING TO THE EPISODIC ACIDIFICATION OF A FORESTED HEADWATER STREAM,
Pennsylvania State Univ., University Park. Forest Resources Lab.
F. I. Potter, J. A. Lynch, and E. S. Corbett.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 293-305, December 1988. 6 fig, 1 tab, 19 ref.

Descriptors: *Water pollution sources, *Acid rain, *Streams, *Headwaters, *Catchment areas, *Acidic streams, *Storm seepage, *Soil water, *Soil porosity, Hydrogen ion concentration, Hydrographs, Pennsylvania, Acid rain effects, Saturated soils, Forest watersheds.

A study was initiated on the Leading Ridge Experimental Watersheds in central Pennsylvania to investigate the extent to which episodic depressions of streamwater pH result from direct channel interception of acidified rainwaters and from rapid subsurface stormflow. During a 4.78-cm rainfall event, stream pH declined from 5.93 to 5.46. Analysis of the storm hydrograph indicated that direct channel interception accounted for only 2.8% of the total stormflow volume but contributed 40% of the total increase in the concentration of H+. At peak flow, channel interception accounted for 5.7% of the stormflow volume and 72% of H+. Large increases in the height of the saturated soil zone and coinciding increases in H+ concentrations in soil water were measured at a number of soil water observation wells. These fluctuations occurred almost simultaneously with measured fluctuations in both streamflow and stream water H+ concentrations, indicating direct interactions between saturated soil water and the storm discharge. These results indicate that catchments in which soil macropores permit rapid subsurface flow could be especially susceptible to stream acidification. (Author's abstract)
W89-06431

TILE DRAIN SAMPLING OF PREFERENTIAL FLOW ON A FIELD SCALE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 7B.
W89-06432

FLUX DENSITY AND BREAKTHROUGH TIMES FOR WATER AND TRACER IN A SPATIALLY VARIABLE, COMPACTED CLAY SOIL,
Agricultural Research Service, University Park, PA. Northeast Watershed Research Center.
A. S. Rogowski.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 327-348, December 1988. 14 fig, 2 tab, 14 ref. EPA Interagency Agreement DW129-303-03-01-0.

Descriptors: *Path of pollutants, *Porosity, *Compacted soils, *Clays, *Water flux, *Infiltration, Tracers, Bromides, Density, Soil water.

Flux density values, computed from observed infiltration and outflow measurements at 184 locations in a 0.3-m thick, 9 m x 23 m layer of compacted clay subsoil, were compared to effective flux density values that are based on breakthrough time distributions for water and bromide tracer over the same area. Results suggest that both water and tracer move at similar rates, but considerably faster than expected, on the basis of flux density alone, and that only a small fraction of the total pore space is involved in active transport. It appears that flow at a point need to be averaged over a suitable interval of time whenever flow rates are low or concentrations small. This could be particularly important for pollutant flows under unsaturated conditions. It also appears that compaction of the clay and the very low permeability of the clay matrix highlight the behavior of preferential flow paths which may have an important impact on both the rate and quality of the flow. (Sand-PTT)
W89-06433

APPLICATION OF SIMPLE SOIL-WATER FLOW MODELS TO THE TRANSFER OF SURFACE-APPLIED SOLUTES TO STREAMS,
Sheffield Univ. (England). Dept. of Geology.
S. T. Trudgill, and N. Coles.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 367-380, December 1988. 4 fig, 2 tab, 20 ref.

Descriptors: *Stream pollution, *Water pollution sources, *Model studies, *Fertilizers, *Path of pollutants, *Soil water, Leaching, Nitrates, Rainfall intensity, Agricultural runoff, Agricultural chemicals.

In the context of leaching of surface-applied nitrate fertilizer to runoff, this paper evaluates the performance of 5 simple predictive models, based upon: (1) field capacity; (2) uniform displacement; (3) wetting front; (4) by-passing (preferential) flow; and (5) soil-water domains. Predicted behavior and observed behavior on an 85-cm depth soil are compared for leaching depth and outflow response. Predictive success of outflow by the models for 40 monitored rainfall events were: (1) 60%; (2) 52%; and (3) 76%. For the by-passing flow model (4), simple prediction of pedal excess flow (4a) gave a success of 80%; where calculations of the operational volume in preferential flow were involved (4b), variations from 20 to 100% success occurred for a range of operational volumes, the lowest volumes giving the greatest success (4c). The soil-water domain model (5) is a simple, predictive scheme involving the classification of outflow events according to antecedent soil moisture (theta-a); the method uses the mobile:retained water content (theta-r) at 2 bars and field capacity (theta-fc). Using soil-water domains alone was of limited success but when the domains were combined with rainfall intensity, the schemes specified outflow exactly. Thus, for theta-a < theta-r, no soil-water outflow occurred, even at high rainfall intensity; for theta-a > theta-fc outflow always occurred, even at low rainfall intensity and for theta-a > theta-r > theta-fc the simple by-passing model (4a) achieved 100% predictive success. The implications for fertilizer applications are discussed. (Author's abstract)
W89-06435

FINITE ELEMENT MODEL OF NITROGEN SPECIES TRANSFORMATION AND TRANSPORT IN THE UNSATURATED ZONE,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. J. Kaluarachchi, and J. C. Parker.
Journal of Hydrology JHYDA7, Vol. 103, No. 3-4, November 30, 1988. 17 fig, 1 tab, 19 ref, 2 append.

Descriptors: *Finite element method, *Nitrogen, *Unsaturated zone, *Mathematical models, *Groundwater pollution, *Path of pollutants, *Fate of pollutants, Cycling nutrients, Ammonia, Nitrates, Nitrification, Denitrification.

A two-dimensional finite element model based on Galerkin's weighted residual approach and incorporating an upstream weighting technique was developed to predict the simultaneous transformation and transport of nitrogen species. The nitrogen cycle used in the analyses assumes first-order rate coefficients for nitrification, denitrification, immobilization and mineralization between the nitrogen species NH4(+), NO3(-), organic-N and denitrified fractions. The NO3(-)-N component in the soil solution was assumed to have negligible adsorption on exchange sites while adsorption of NH4(+) was assumed to be represented by a Freundlich type nonlinear isotherm. The accuracy and validity of the proposed model was examined by comparison with analytical model results and available field data. The results showed improved accuracy and stability with the upstream weighting approach in comparison to the standard weighted residual method. A sensitivity study on the kinetics of the nitrogen cycle showed that both concentration and cumulative mass distribution of different nitrogen species are substantially affected by the nitrification rate but to a lesser extent by the distribution coefficient for NH4(+) adsorption and less so by nonlinear coefficient p. To evaluate the applicability of the model in actual field situations, data on groundwater nitrogen concentration beneath a functioning drainfield site were compared with the results of numerical simulations. Predicted results agreed with the observed data within the bounds of experimental errors. (Author's abstract)
W89-06458

ANAEROBIC BIODEGRADATION OF POLYCHLORINATED BIPHENYLS BY BACTERIA FROM HUDSON RIVER SEDIMENTS,
New York State Dept. of Health, Albany. Wadsworth Center for Labs. and Research.
M. Chen, C. S. Hong, B. Bush, and G. Y. Rhee.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 95-105, October 1988. 1 fig, 3 tab, 32 ref.

Descriptors: *Biodegradation, *Polychlorinated biphenyls, *Fluvial sediments, *Aquatic bacteria, *Aroclors, *Fate of pollutants, Anaerobic conditions, Microbial degradation, Radioactive tracers, Hudson River.

Anaerobic biodegradation of monochlorobiphenyls; a tetrachlorobiphenyl; Aroclor 1221, a polychlorinated biphenyl (PCB) mixture; and sediment PCBs was investigated by using mixed bacterial populations from Hudson River sediments studied by PCB enrichment. When the bacteria were incubated with Aroclor 1221, the disappearance of congeners was in general inversely related to GC retention time and thus indirectly to the octanol/water partition coefficient. When incubated with 14C-labeled monochlorobiphenyls, labeled-CO2 was detected, but methane was not. Radioactivity was also found in the cell material and the aqueous fraction. 2,4,2',4'-Tetrachlorobiphenyl produced little evidence of biodegradation or reductive dechlorination. Inoculation of anaerobic sediments from the Hudson River with the mixed population produced a marked decrease in sediment PCBs, whereas uninoculated sediments were observed to have little change. This decrease was also related to the partition coefficient. (Author's abstract)
W89-06470

ENVIRONMENTAL BEHAVIOR OF CHEMICALS IN SOIL: ATRAZINE AS AN EXAMPLE,
Istituto Superiore di Sanita, Rome (Italy).
C. Lupi, A. R. Bucchi, A. Piccioni, and G. A. Zapponi.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 133-142, October 1988. 7 fig, 6 tab, 8 ref.

Descriptors: *Model studies, *Fate of pollutants, *Biodegradation, *Mathematical models, *Atrazine, *Triazine pesticides, *Path of pollutants, *Soil pollution, *Pesticide residues, Capillarity, Soil organic matter, Microbial degradation, Organic carbon, Percolation, Adsorption.

A mathematical model was developed and used to estimate the soil vertical distribution of atrazine dispersed in the environment. Water transport, rise due to capillarity, and partition among soil-contained water, air, and organic matter, as well as degradation processes, are considered. As far as the vertical mobility in soil is concerned, the model has been derived from a previously published study. Such a model has been extended to include a procedure which takes into account the atrazine mobility due to gravitational water flow. The organic carbon concentration gradient in soil was also considered in the evaluation when assessing partition processes, according to other previously published models. The degradation processes are assumed to be first order, linearly related with O.C. content in soil. The application of this model to two sets of soil data demonstrated that atrazine requires a long time (2 years or more, depending on soil features) in order to percolate at a depth comparable with those of a groundwater source. (Author's abstract)
W89-06473

CLIMATOLOGICAL VARIABILITY OF SULFUR DEPOSITIONS IN EUROPE,
Environmental Protection Agency, Washington, DC. Office of Air and Radiation.
For primary bibliographic entry see Field 2B.
W89-06486

ASSESSMENT OF IMPACTS OF POSSIBLE CLIMATE CHANGES ON THE RESULTS OF THE IIASA RAINS SULFUR DEPOSITION MODEL IN EUROPE,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
S. E. Pitovranov.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 95-119, 1988. 9 fig, 5 tab 23 ref.

Descriptors: *Acid rain, *Sulfur, *Deposition, *Climatology, *Mathematical models, *Europe, Cyclones, Regression analysis, Rainfall distribution, Path of pollutants, Air pollution, Water pollution prevention, Air temperature, Weather patterns.

The International Institute for Applied Systems Analysis (IIASA) Regional Acidification Information and Simulation (RAINS) model attempts to provide scientific information for long-term strategies for controlling acidification impacts in Europe. Various methods for determining features of climatic change relevant to long-range atmospheric transport of sulfur were examined, and a preliminary effort in applying these changes to the RAINS model was made. The relationship between patterns in atmospheric circulation in Europe and the temperature regime of the Northern Hemisphere over the same period were analyzed. The basis for classifying different types of atmospheric circulation or large-scale weather patterns (commonly known as Grosswettertypes (GWT-s) or Grosswetterlagen (GWL-n)) is the identification of the position of centers of cyclones, ridges and troughs. The linear regression between the frequency distribution of GWL-n and the deviation in the mean annual Northern Hemisphere extratropical temperatures from the 90-yr period (1891 to 1980) were tested. The results show that the null hypothesis, i.e. that there is no linear relationship, is rejected at the 95% probability level (assuming a normal distribution) for several GWT-s and GWL-n. Changes in GWT-s and GWT-n frequency distribution associated with global warming could substantially change the long-range transport of pollutants over Europe. For example, the decrease in frequency of zonal circulation regimes and the more frequent meridional and blocked circulations (especially easterly flows) could result in a decrease of the existing net export of sulfur pollutants from western to eastern Europe during the winter months. (Author's abstract)
W89-06487

BIOGEOCHEMISTRY OF TWO APPALACHIAN DECIDUOUS FOREST SITES IN RELATION TO EPISODIC STREAM ACIDIFICATION,
Pennsylvania State Univ., University Park. School of Forest Resources.
D. R. Dewalle, W. E. Sharpe, and P. J. Edwards.
Water, Air, and Soil Pollution WAPLAC, Vol. 40,

No. 1-2, p 143-156, 1988. 5 tab, 37 ref.

Descriptors: *Biochemistry, *Acid rain, *Acid streams, *Forest watersheds, *Path of pollutants, *Geochemistry, Soil chemistry, Sulfates, Cations, Pennsylvania, West Virginia, Leachates, Carbonates, Throughfall.

Bulk precipitation, throughfall, and soil water chemistry were studied from November 1983 to November 1984 at two ridge-top Appalachian deciduous forest sites to isolate causes of differing episodic stream acidification. The Fork Mountain site in West Virginia, which exhibited little episodic stream acidification, had lower deposition of H(+) and SO4(--) and greater reductions of H(+) in the water circulating through the forest canopy, forest floor, and mineral soil than the Peavine Hill site in Pennsylvania. Greater neutralization at Fork Mountain was linked to higher Ca and Mg carbonate contents in the sandstone and shale soil parent materials. Fork Mountain had greater amounts of exchangeable bases in the organic and mineral soil horizons. Neither site appeared to be accumulating SO4(--) in the soil, with Peavine Hill losing 56% more than was received in bulk deposition. Anions in soil leachate at Fork Mountain were largely balanced by Ca(2+) and Mg(2+), while at the Peavine Hill site Al(3+) was the dominant cation. Results suggest that the typically-low carbonate content of sandstone and shale soil parent materials commonly found in Appalachian forests may be a key parameter controlling soil and stream acidification. Data for the one-year period also suggest bulk deposition of H(+) was 63% greater at Peavine Hill than Fork Mountain. (Author's abstract)
W89-06488

LINEAR PROGRAMMING FOR ABATEMENT OF NITROGEN OXIDES ACID RAIN DEPOSITION,
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
D. G. Wareham, E. A. McBean, and J. M. Byrne.
Water, Air and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 157-175, 1988. 2 fig, 9 tab, 27 ref.

Descriptors: *Linear programming, *Nitrogen compounds, *Oxides, *Acid rain, *Air pollution effects, *Water pollution prevention, Computer models, Water pollution sources, Canada, Case studies, Comparison studies, Path of pollutants, Deposition, Public policy.

Linear programming is used to examine NOx as an air quality management problem. Through the use of transfer coefficients, which translate source emissions of NOx into receptor impacts, the model developed herein seeks to minimize the total cost of reducing emissions from 14 major Canadian point sources. The model operates with the constraint that the wet deposition at 5 sensitive receptors must be reduced by at least some minimum amount. Several different reductions in wet deposition are used to observe the increase in costs associated with a systematic tightening of the constraint relationships. A particular level of reduction is used to examine, on a more detailed level, the sources requiring some level of removal. These case study results and an analysis of the rationale for their solution are presented. Also presented is a comparison between this type of optimization strategy and the scenario of a single across-the board emissions cutback. From NOx considerations alone, it would seem more expedient to concentrate current research efforts into developing technologies to further reduce vehicle emissions, since their magnitude considerably outweighs those from the point sources. (Author's abstract)
W89-06489

ADSORPTION-DESORPTION OF ATRAZINE ON FOUR SOILS OF HYDERABAD,
Andhra Pradesh Agricultural Univ., Hyderabad (India).
S. Raman, M. Krishna, and P. C. Rao.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 177-184, 1988. 2 fig, 4 tab, 22 ref. ICAR Project F(13)-13/80 SW and DF.

Descriptors: *Sorption, *Atrazine, *Triazine pesticides, *Adsorption, *Path of pollutants, Herbicides, Degradation, India, Organic matter, Clays, Hysteresis, Soil contamination, Solute transport, Statistical analysis.

The adsorption-desorption equilibrium of atrazine (2-chloro,4-ethylamino, 6-isopropyl amino-1,3,5 triazine) was studied by the batch equilibration method at 27 + or -1 C on four soils of Hyderabad, India. Adsorption isotherms conformed to the Freundlich equation (A = KC to the 1/n power). K increased in the same order as the organic C content of the soils. Desorption studies were conducted by repeated replacement of 5 ml of the supernatant equilibrium solutions after adsorption, with 0.01 M CaCl2. Desorption isotherms showed considerable hysteresis which was more prominent when the desorption was carried out with higher adsorbed concentration of atrazine. Desorption from the lowest level of adsorbed atrazine (3 to 5 micrograms/g soil) was close to the adsorption isotherm. The cumulative desorption after four desorption steps covering five days was significantly different at the 1% level, for different initial adsorbed concentrations of atrazine. Desorption was significantly higher at the lowest adsorbed level of atrazine. The soils differed significantly at 6% level for desorption and the amount desorbed decreased in the inverse order of organic C. Desorption isotherms also conformed to Freundlich equation but K and n values were both higher than that for adsorption and increased with increase in initially adsorbed concentration of atrazine. Desorption thus confirmed the irreversible nature of the adsorption of atrazine on these soils. The quantitative factors and reasons for desorption are discussed. (Author's abstract)
W89-06490

FOREST CLEARCUTTING EFFECTS ON TRACE METAL CONCENTRATIONS: SPATIAL PATTERNS IN SOIL SOLUTIONS AND STREAMS,
State Univ. of New York Coll. at Plattsburgh. Center for Earth and Environmental Science.
For primary bibliographic entry see Field 4C.
W89-06491

ANNUAL MONITORING OF RAINWATER SULPHATE IN AN URBAN ZONE OF ROME (ITALY),
Istituto Superiore di Sanita, Rome (Italy). Lab. di Igiene del Territorio.
F. D'Innocenzio, and M. Ottaviani.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 197-202, 1988. 2 fig, 3 tab, 15 ref.

Descriptors: *Urban hydrology, *Sulfates, *Acid rain, *Italy, Urban areas, Monitoring, Spectrometry, Chemistry of precipitation, Path of pollutants, Air pollution, Rome.

The sulfate ion concentrations in rainwater samples, collected in a central area of Rome (Italy), were measured by an indirect atomic absorption spectrometric method to determine the degree of pollution from acid rain. The total deposition was collected monthly from May 1985 to June 1986 at two different sites, one 1.5 m above the ground, the other on a flat roof of a building 20 m high. The measurements followed a Gaussian distribution for all samples throughout the year. The SO4(--) annual weighted average concentration determined from the monthly volume of rainwater collected at ground level, was 152 microeq/L. This value is comparable with results from samples taken in urban sites by the 19 stations forming the Northern Italian Atmospheric Deposition Network. The reproducibility of sample preparations and analysis were found to have a max SD of + or - 20%. The month to month variation in SO4(--) concentration varied from 3 to 27 micrograms/ml. (Geiger-PTT)
W89-06492

BIOCONCENTRATION, EXCRETION AND METABOLISM OF BIS (TRI-N-BUTYLTIN) OXIDE AND TRIPHENYLTIN CHLORIDE BY GOLD FISH,
Shiga Prefectural Inst. of Public Health and Environmental Science, Otsu (Japan).
T. Tsuda, M. Wada, S. Aoki, and Y. Matsui.
Toxicological and Environmental Chemistry TXECBP, Vol. 18, No. 1, p 11-20, 1988. 4 fig, 24 ref.

Descriptors: *Path of pollutants, *Biological magnification, *Metabolism, *Excretion, *Goldfish, *Tin, *Pesticides, Heavy metals, Tissue analysis, Fish *Metal organic pesticides.

Bioconcentration and excretion of bis (tri-n-butyltin) oxide ((Bu3Sn)2O)) and triphenyltin chloride (Ph3SnCl) were studied in goldfish (Carassius auratus). Logarithm of the bioconcentration factors (log BCF) after 14 days exposure was 3.09 (n = 3) for (Bu3Sn)2O and 2.41 (n = 3) for Ph3SnCl. Excretion of (Bu3Sn)2O and Ph3SnCl from goldfish was carried out in clean water for 14 days after bioconcentration of these chemicals in the test water for 14 days. The excretion rate constants were 0.08/day for (Bu3Sn)2O and 0.04/day for Ph3SnCl. Further, metabolism in goldfish was studied on (Bu3Sn)2O and Ph3SnCl. Bu2Sn(2+) and BuSn(3+) or Ph2Sn(2+) and PhSn(3+), metabolites of (Bu3Sn)2O or Ph3SnCl, were detected in goldfish during the bioconcentration experiment (14 days). (Author's abstract)
W89-06504

BIOCONCENTRATION AND EXCRETION OF BENTHIOCARB AND SIMETRYNE BY WILLOW SHINER,
Shiga Prefectural Inst. of Public Health and Environmental Science, Otsu (Japan).
T. Tsuda, S. Aoki, M. Kojima, and H. Harada.
Toxicological and Environmental Chemistry TXECBP, Vol. 18, No. 1, p 31-36, 1988. 2 fig, 5 ref.

Descriptors: *Path of pollutants, *Biological magnification, *Excretion, *Herbicides, *Metabolism, *Benthiocarb, *Simetryne, Pesticides, Fish, Kinetics, Shiner.

Bioconcentration and excretion of the herbicides benthiocarb and simetryne were studied in willow shiner (Gnathopogon caerulescens). Average values of logarithm of the bioconcentration factors (log BCF) for 14 days were 1.82 for benthiocarb and 0.31 for simetryne. Excretion of benthiocarb and simetryne from willow shiner was carried out in clean water for 7 days after bioconcentration of these chemicals in the test water for 14 days. The excretion rate constants were 0.073/h for benthiocarb and presumed to be about 0.13/h for simetryne, assuming their processes to be first-order kinetics. These results indicate that both herbicides are rapidly excreted from fish. (Doria-PTT)
W89-06505

NEW EQUATIONS OF THE SPREADING OF A TRACER IN GROUNDWATER (NOUVELLES EQUATIONS DE PROPAGATION D'UN POLLUANT DANS UNE NAPPE SOUTERRAINE),
Lille-1 Univ., Villeneuve d'Ascq (France). Lab. de Geologie Appliquee.
E. Carlier.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 189-197, November 15, 1988. 3 tab, 4 ref. English summary.

Descriptors: *Path of pollutants, *Tracers, *Groundwater pollution, *Groundwater movement, Fracture permeability, Mathematical analysis, Porous media, Estimating equations.

Groundwater pollution studies generally involve dispersivity as a parameter. The methods used to obtain its value are tedious and need the use of computer programs or nomographs. Moreover, it has been shown that dispersivity may depend on time. For a model of a fractured medium (parallel fractures with various apertures and frequencies), two functions C(x,t) were worked out, including intrinsic parameters, for which determination is directly worked out from an experimental graph. These parameters being determined, it will be possible to make forecasts about the propagation of groundwater pollution. The method has been tested against the result of two tracer experiments

carried out in chalk and seems to be applicable for any kind of porous or fractured medium. (Author's abstract)
W89-06519

USE OF POLYNOMIAL EXPRESSIONS TO DESCRIBE THE BIOCONCENTRATION OF HYDROPHOBIC CHEMICALS BY FISH,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
D. W. Connell, and D. W. Hawker.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 242-257, December 1988. 8 fig, 1 tab, 28 ref.

Descriptors: *Bioaccumulation, *Fish, *Mathematical equations, *Biological magnification, *Chlorinated hydrocarbons, Solubility, Equilibrium.

For the bioconcentration of hydrophobic chemicals by fish, relationships have been previously established between uptake rate constants (k sub 1) and the octanol/water partition coefficient (K sub OW), and also between the clearance rate constant (k sub 2) and K sub OW. These have been refined and extended on the basis of data for chlorinated hydrocarbons, and closely related compounds including polychlorinated dibenzodioxins, that covered a wider range of hydrophobicity ($2.5 < \log K_{OW} < 9.5$). This has allowed the development of new relationships between the partition and various factors, including the bioconcentration factor (as log K sub B), equilibrium time (as log t sub eq), and maximum biotic concentration (as log C sub B), which include extremely hydrophobic compounds previously not taken into account. The shape of the curves generated by these equations is in qualitative agreement with theoretical prediction and is described by polynomial expressions which are generally approximately linear over the more limited range of coefficient values used to develop previous relationships. The influences of factors such as hydrophobicity, aqueous solubility, molecular weight, lipid solubility, and also exposure time were considered. Decreasing lipid solubilities of extremely hydrophobic chemicals resulted in increasing clearance rate constants, as well as decreasing equilibrium times and bioconcentration factors. (Author's abstract)
W89-06524

BIOCONCENTRATION OF CHLORINATED HYDROCARBONS FROM SEDIMENT BY OLIGOCHAETES,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
D. W. Connell, M. Bowman, and D. W. Hawker.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 293-302, December 1988. 4 fig, 1 tab, 21 ref.

Descriptors: *Biological magnification, *Chlorinated hydrocarbons, *Sediments, *Oligochaetes, *Bioaccumulation, Annelids, Interstitial water, Benthic fauna, Metabolism, Respiration.

Previously published data on the accumulation of 15 chlorinated hydrocarbons from sediment by oligochaetes have been interpreted on the basis of bioconcentration from interstitial water. Calculation of the interstitial water concentration allowed determination of uptake and clearance rate constants together with bioconcentration factors (K_B) for these compounds. These three factors each exhibited a systematic relationship to the octanol/water partition coefficient (K sub OW). The log K sub B versus log K sub OW relationship was roughly linear over the log K sub OW range from 4.4 to 6.4 and displayed an increasing nonlinear deviation for log K sub OW values > 6.4. These relationships are qualitatively similar to those established for other aquatic organisms where bioconcentration from water was the mechanism involved. This suggests that interstitial water may be the phase from which lipophilic compounds in sediment are bioconcentrated by oligochaetes. An expression relating the bioconcentration factor to the biotic concentration and various sediment characteristics has also been developed. (Author's abstract)
W89-06528

REDUCTIVE DECHLORINATION OF POLYCHLORINATED BIPHENYLS BY ANAEROBIC MICROORGANISMS FROM SEDIMENTS,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
For primary bibliographic entry see Field 5D.
W89-06529

BEHAVIOR OF PARTICULATE CARBOHYDRATES AND AMINO ACIDS IN THE ESTUARY OF THE TAMA RIVER,
Tokyo Metropolitan Univ. (Japan). Dept. of Chemistry.
M. Ochiai, M. Ogino, K. Sasaki, and T. Okazawa.
Marine Chemistry MRCHBD, Vol. 25, No. 3, p 265-278, November 1988. 5 fig, 6 tab, 27 ref.

Descriptors: *Urban runoff, *Urban areas, *Particulate matter, *Amino acids, *Carbohydrates, *Estuaries, *Tama River, *Japan, *Eutrophication, Chemistry, Rivers, Urban areas, Chlorophyll, Electrochemistry, Flocculation.

Surface waters were sampled in the estuary of the Tama River, a typical highly eutrophic urban river, and the particulate matter was analyzed for carbohydrates, amino acids, and chlorophyll pigments. Particulate carbohydrates (PCHO) and particulate amino acids (PAA) were found to be in two fractions: one transported from the upper reaches and another produced in situ. Arabinose was used as an index of terrestrial origin and chlorophyll pigments for in situ production. PCHO and PAA transported from the upper reaches of the river (PCHO-AL and PAA-AL) differed in behavior in estuarine water. PAA-AL decreased sharply with increase in Cl(-) concentration, while PCHO-AL decreased with dilution by seawater. This difference in behavior in the estuary may originate from the difference in charge characteristics of these compounds. It is suggested that particulate matter may undergo differential flocculation due to the different electric charge in the estuarine water. (Author's abstract)
W89-06545

ACCUMULATION OF RADIONUCLIDES IN AQUATIC PLANTS (UNDER EXPERIMENTAL CONDITIONS)(NAKOPLENIE RADIONUKLIDOV VODNYMI RASTENIIAMI (V USLOVIYAKH MODEL'NOGO EKSPERIMENTA)),
Akademiya Nauk Litovskoi SSR, Vilnius. Inst. Botanik.
D. P. Marchiulenene.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 3, p 80-83, 1987. 2 tab, 8 ref. English summary.

Descriptors: *Path of pollutants, *Radioisotopes, *Bioaccumulation, *Aquatic plants, Water pollution, Contamination, Radioactive contamination.

The intensity and levels of Sr90, Cs137, Ce144, Ru106 and Pb210 accumulation in fresh water plants differ considerably under experimental conditions. The Ce, Ru, and Pb radionuclides accumulate in aquatic plants more intensively and with higher accumulation coefficients than the Sr and Cs radionuclides. This difference in the levels of accumulation may be accounted for by different absorption mechanisms of these radionuclides by the plant cells. The data obtained permit the hypothesis that in aquatic plants the accumulation coefficients of those radionuclides which in the water environment are mainly in the colloidal state and which enter into the cells of aquatic plants chiefly by adsorption differ only slightly. In these cases, data from model experiments may be used to estimate and predict the intensity and degree of radioactive contamination of water basins. (Author's abstract)
W89-06560

ACCUMULATION OF OIL HYDROCARBONS BY BIVALVED MOLLUSKS MYTILIS GALLOPROVINCIALIS L. (AKKUMULYATSIYA UGLEVODORODOV NEFTI DVUSTVORCHATYMI MOLLYUSKAMI MYTILUS GALLOPROVINCIALIS L.),
Akademiya Nauk URSR, Sevastopol. Inst. Biologii Yuzhnykh Morei.
T.L. Shchekaturina, and O. G. Mironov.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 71-76, 1987. 4 fig, 2 tab, 13 ref. English summary.

Descriptors: *Mollusks, *Bioaccumulation, *Hydrocarbons, *Oil pollution, *Path of pollutants, Black Sea, Nutrients, Deficient elements, Chemical properties.

Hydrocarbon accumulation was studied in Mytilus galloprovincialis L. mussels collected in Black Sea bays having different degrees of pollution. The process was shown to depend on the initial degree of pollution of the mollusks by oil hydrocarbons and on the physiological state associated with a nutrient deficiency. The accumulation of individual alkanes is determined by the chemical properties and composition of the pollutant. (Author's abstract)
W89-06568

UNSATURATED SEEPAGE AND SUBTERRANEAN HOLES: CONSPECTUS, AND EXCLUSION PROBLEM FOR CIRCULAR CYLINDRICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2F.
W89-06576

SEEPAGE EXCLUSION PROBLEM FOR SPHERICAL CAVITIES,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2F.
W89-06577

SOLUTE AND WATER MOVEMENT IN UNSATURATED SOILS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
C. J. Barnes.
Water Resources Research WRERAO, Vol. 25, No. 1, p 38-42, January 1989. 1 fig, 14 ref.

Descriptors: *Soil water, *Path of pollutants, *Unsaturated flow, *Solute transport, *Unsteady flow, Gravity flow, Aeration zone, Mathematical models.

Chromatographic$_1$ theory of competitive solute movement through porous, reactive soils with nonlinear adsorption isotherms is extended to conditions of unsteady flow in the unsaturated zone under gravity. By treating water content as an extra solute component, equations governing coupled movement of solute and water through reactive soils under gravity are shown to be a special case of those governing competitive solute movement, leading to a quantitative description of the coupled movement of the water and solute fronts through a soil column. When one solution displaces another at a different concentration and water potential in a reactive soil, the solute and water front splits up into two distinct subfronts, separated by a region in which both concentration and potential are constant. Each subfront is characterized by a region in which water content and concentration vary in a predetermined manner, according to certain functions (characteristics), one of which must remain constant over each subfront. Only in certain simple cases will solute concentration and water content vary independently of each other. The case in which the hydraulic conductivity depends on solute concentration is explicitly considered. (Author's abstract)
W89-06578

EFFICIENT FINITE ELEMENT METHOD FOR MODELING MULTIPHASE FLOW,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
J. J. Kaluarachchi, and J. C. Parker.

Water Resources Research WRERAO, Vol. 25, No. 1, p 43-54, January 1989. 10 fig, 3 tab, 18 ref, 3 append. DOE contract DE-AC06-76RLO and EPA cooperative agreement CR-812073-01.

Descriptors: *Model studies, *Path of pollutants, *Oil pollution, *Finite element method, *Multiphase flow, *Mathematical models, *Vadose water, *Oily water, Simulation analysis, Groundwater pollution, Soil water.

A two-dimensional finite element model based on Galerkin's weighted residual approach and an upstream weighting technique was developed to predict simultaneous flow of water and oil in a three-fluid phase system with gas assumed at constant pressure. Element matrices were computed using the influence coefficient method for both Picard and Newton-Raphson nonlinear iteration schemes. A number of hypothetical simulations were performed in both one and two dimensions to evaluate the accuracy and efficiency of the various schemes with respect to handling of nonlinear soil properties, time marching, mass balance errors, soil nonhomogeneity, and effects of upstream weighting. Results indicate that the Picard scheme appears to be as effective as the Newton-Raphson scheme while requiring substantially less computational effort if upstream weighting is employed. The Picard method without upstream weighting did not provide satisfactory convergence behavior. Results from problems involving extreme soil nonhomogeneity indicate that accurate solutions can be obtained with the Picard method with the proper use of upstream weighting. Saturation-pressure derivative terms in the formulation can be evaluated using both analytical and chord-slope methods. Results indicate that time averaging of these terms is critical for good mass balance results especially during redistribution. Overall mass balance is also sensitive to the fluid-dependent scaling parameters of the constitutive relationships. (Author's abstract)
W89-06579

SOLUTIONS APPROXIMATING SOLUTE TRANSPORT IN A LEAKY AQUIFER RECEIVING WASTEWATER INJECTION,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
C. S. Chen.
Water Resources Research WRERAO, Vol. 25, No. 1, p 61-72, January 1989. 9 fig, 38 ref, append. EPA project CR-813529.

Descriptors: *Path of pollutants, *Solute transport, *Leaky aquifers, *Underground waste disposal, *Injection wells, Mathematical models, Wastewater pollution, Groundwater pollution, Groundwater movement.

A mathematical model amenable to analytical solution techniques is developed to investigate contaminant transport from a injection well into a leaky aquifer system, which comprises a pumped and an unpumped aquifer connected to each other by a aquitard. A steady state groundwater flow field is assumed, where the injected fluids move horizontally in the pumped aquifer and vertically in the aquitard. The unpumped aquifer is assumed to remain in hydrostatic condition due to its large transmissivity. Descriptions of groundwater velocities are based on appropriate leaky aquifer well hydraulics. The model assumes that contaminants are transmitted in the pumped aquifer by radial advection, and in the aquitard by vertical one-dimensional advection and longitudinal dispersion. Two coupled linear differential equations were formulated to deal with this transport problem; they involve variable coefficients dependent on Bessel functions. The unpumped aquifer was incorporated into the model as a boundary condition. Within the context of the assumed hydrogeological conditions, the proposed model appears to be a valid approximation to the problem of interest. Type cures for concentration evaluated at the well bore and the top of the aquitard are given, which can be employed to estimate whether the unpumped aquifer would be polluted as the consequence of the injection. Neglecting the leakage effects in a leaky aquifer can cause significant error in studying the transport problem. (Author's abstract)
W89-06581

OBSERVATIONS OF WATER AND OIL INFILTRATION INTO SOIL: SOME SIMULATION CHALLENGES,
Battelle Pacific Northwest Labs., Richland, WA. Geosciences Dept.
J. W. Cary, J. F. McBride, and C. S. Simmons.
Water Resources Research WRERAO, Vol. 25, No. 1, p 73-80, January 1989. 6 fig, 2 tab, 20 ref. DOE contract DE-AC06-76RLO.

Descriptors: *Path of pollutants, *Multiphase flow, *Infiltration rate, *Oil-water interfaces, *Oil pollution, Groundwater pollution, Wetting, Simulation, Aeration zone, Soil types.

Experiments were performed to test the ability of multiphase flow theory to predict the flow behavior of an immiscible organic liquid entering an unsaturated soil medium. The infiltration and redistribution behavior of water followed by oil, and of oil followed by water, in soil columns was observed. Experiments involved both liquid entry at the top of columns with downward flow and entry at the base of columns with upward flow. Two oils (specific gravity, 0.80 and 0.86; viscosity ratio relative to water, 4.7 and 77) were used in three soils: a silt loam, a sandy loam, and a sand. The results from 17 different infiltration scenarios, each about 8 hr in duration, were compared with the predicted results obtained from a simplified explicit finite difference code for three-phase flow in a one-dimensional system. Code input required only the soil water release curve, the bulk density, the initial water content, the saturated waste conductivity, the oil viscosity, and the interfacial tensions between oil and air, and water and oil. The code made reasonably good predictions of water and oil redistribution in the silt loam and loamy sand, when oil followed water infiltration. It made less than satisfactory predictions for the sand, possibly because hysteresis was neglected. Infiltration time for small amounts of oil was often shorter than the code predicted for the silt loam and loamy sand. The code, which did not account for hysteresis or unstable liquid flow, also did a poor job of predicting oil and water contents when water followed oil into the soils. Visual evidence of unstable flow of the more viscous oil entering the water wet loamy sand is presented, and the implications for one-and two-dimensional experiments are discussed. The experimental results are presented to facilitate the preliminary validation of other immiscible flow codes. (Author's abstract)
W89-06582

MODELING THE TRANSPORT OF VOLATILE ORGANICS IN VARIABLY SATURATED MEDIA,
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
B. E. Sleep, and J. F. Sykes.
Water Resources Research WRERAO, Vol. 25, No. 1, p 81-92, January 1989. 12 fig, 3 tab, 33 ref.

Descriptors: *Model studies, *Volatile organic compounds, *Path of pollutants, *Solute transport, *Mathematical models, *Groundwater pollution, *Mass transfer, *Saturated flow, Volatility, Chlorinated hydrocarbons, Simulation.

The understanding of the processes of dissolution, volatilization, and gas-liquid partitioning in porous media is very limited. The few models which attempt to characterize the transport of volatile organics in variably saturated media all assume that mass transfer processes are at equilibrium. In addition, gas phase advection is neglected by assuming that gas phase pressures are uniformly atmospheric and that density gradients are negligible. In this study a model was developed to solve for water phase flow and transport and density dependent gas phase flow and transport. Simple expressions for dissolution were incorporated into the model. The transport of trichloroethylene in a variably saturated vertical cross section, under a variety of conditions, was simulated. Results of the simulations appeared qualitatively correct. The importance of gas phase processes in increasing subsurface contamination from similar analytical and/or numerical models, or suitable experimental studies, excluded the possibility of validating or verifying, the model. (Author's abstract)
W89-06583

CRITICAL EVALUATION OF RECENT DEVELOPMENTS IN HYDROGEOCHEMICAL TRANSPORT MODELS OF REACTIVE MULTICHEMICAL COMPONENTS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
For primary bibliographic entry see Field 7C.
W89-06584

INTERACTION OF FINE SEDIMENT WITH ALLUVIAL STREAMBEDS,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2J.
W89-06588

REVIEW OF INTERMEDIATE-SCALE EXPERIMENTS FOR SUBSURFACE MICROBIOLOGY AND CHEMISTRY,
Battelle Pacific Northwest Labs., Richland, WA.
G. P. Streile, J. M. Zachara, and J. K. Fredrickson.
Proceedings of an OHER/DOE-Sponsored Workshop at the University of Delaware's Virden Center, Lewes, Delaware, April 12-14, 1987. Report No. DOE/ER-0383, (1987). 45p, 4 ref, 2 append. DOE Contract DE-AC06-76RLO 1830.

Descriptors: *Experimental design, *Conferences, *Path of pollutants, *Microbiological studies, *Chemical analysis, *Groundwater pollution, Groundwater movement, Solute transport, Hazardous wastes, Organic compounds, Inorganic compounds, Research priorities.

This report contains the synopsis of a workshop that was sponsored by the Department of Energy (DOE) Office of Health and Environmental Research (OHER) and the Pacific Northwest Laboratory (PNL) to review proposed experiments and candidate flow cell designs for the intermediate-scale experimental facilities in Subsurface Experimental Research Facilities (SERF). Intermediate-scale research represents an approach to the investigation of the integrated effects of chemical, microbiologic, and hydrologic phenomena on contaminant transport in the subsurface that is different from field injection experiments. Intermediate-scale experiments may provide flexibility for hypothesis-driven research and an ability to use potentially hazardous organic and inorganic chemical mixtures relevant to the DOE mission. Moreover, a controlled, isolated system for the study of contaminant dynamics at the mesoscopic scale could also be used to evaluate remediation techniques for detoxification of soils and groundwater on DOE lands. Specifically, the workshop was intended to: (1) review the technical merits and shortcomings of the intermediate-scale concept and initial designs of multidimensional, intermediate-scale flow cells; and (2) identify what experiments are most appropriate to conduct at this scale, and those that are needed to advance the state of science. (Lantz-PTT)
W89-06623

AIR POLLUTION AND ACID RAIN: THE BIOLOGICAL IMPACT,
Lancaster Univ. (England).
A. Wellburn.
Longman Scientific and Technical, Essex, England. 1988. 274p.

Descriptors: *Ecology effects, *Lake acidification, *Air pollution effects, *Acid rain, *Water pollution sources, Chemical reactions, Soil contamination, Path of pollutants, Bioaccumulation, Metabolism.

Acid rain, and air pollution in general, is an issue of enormous importance throughout the industrialized world. This book adopts a unique approach to the problem, concentrating on how different bio-

logical mechanisms are affected by airborne pollution. Beginning with a consideration of the sources of various atmospheric pollutants (and also natural emissions), and their reactions in the atmosphere and in rain, soils and lakes, the author goes on to discuss how each of the different pollutants and their derivatives gains access to living organisms. The reactions within animal and plant cells that are especially sensitive to these intruders are examined, and the ways in which each organism attempts to counteract or resist any deleterious effects, are outlined. Coverage is not restricted to specific geographical areas; a global view is taken of the effects of air pollutants and acid rain on the living world as a whole. A key conclusion is that while the uptake mechanisms (in lungs, gills, stomata and roots) and the nature of the observed effects and injuries across the plant and animal kingdoms are very different, the underlying cellular events exhibit many more similarities than differences. (Lantz-PTT)
W89-06630

FATE AND TRANSPORT OF SEDIMENT-ASSOCIATED CONTAMINANTS,
Environmental Research Lab., Athens, GA.
A. J. Medine, and S. C. McCutcheon.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-139944. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/356, December 1987. 109p, 12 fig, 7 tab, 138 ref.

Descriptors: *Sorption, *Path of pollutants, *Fate of pollutants, *Sediments, Water pollution sources, Metals, Organic compounds, Streams, Lakes, Model studies, Advection, Adsorption.

Although sediments generally are considered to provide beneficial effects in terms of water quality movement through the 'sorption' of pollutants from the water column, contaminated sediments also may result in adverse effects. The interactions of both metals and organic contaminants with suspended and bed sediments significantly affects the transport and transformation of these pollutants in streams and lakes. Information about these interactions is important in assessing hazards of pollutant exposure in freshwater systems. Research into the fate and transport of sediment-associated contaminants is reviewed. An overview of contaminant modeling is provided along with model descriptions of chemical and biological transformation processes. Research on the physical movement of contaminated sediments is presented, including near bed sediment transport and advective-dispersive transport in the water column. Adsorption-desorption is clearly the most dominant of the many processes that are important in assessing the hazards associated with contaminated sediments. Additional research is needed to formulate mechanistic models that accurately reflect the adsorption-desorption process for both metals and organics in natural systems containing a mixture of sediment types. (Author's abstract)
W89-06639

PROCEEDINGS: THIRD ANNUAL ACID RAIN CONFERENCE FOR THE SOUTHERN APPALACHIANS.
Available from the National Technical Information Service, Springfield, VA 22161, as DE87-900625. Price codes: A04 in paper copy, A01 in microfiche. Report No. TVA/ONRED/AWR--87/15, December 1986. October 277-29, 1986, Gatlinburg, TN. 87p. Edited by Harvey Olem.

Descriptors: *Abstracts, *Conferences, *Air pollution effects, *Acid rain, *Acidification, *Appalachian mountains, Forests, Aquatic environment, Regulations.

Abstracts from each of the papers presented at The Third Annual Acid Rain Conference for the Southern Appalachians are presented in this report was to provide a forum to report progress and exchange information on terrestrial and aquatic research orgamizations, and universities, and to encourage better coordination of research efforts to stimulate more efficient and effective research in the Southern Appalachians. The following topics were included: effects of acid rain on forests, effects of acid rain on the aquatic environment, general effects of acidification, and the regulatory aspects of acid rain. (Lantz-PTT)
W89-06643

K-1407-B AND K-1407-C GROUNDWATER ASSESSMENT PLAN,
Oak Ridge Gaseous Diffusion Plant, TN.
J. L. Haymore.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-002171. Price codes: A04 in paper copy, A01 in microfiche. Report No. K/HS--200, October 30, 1987. 78p, 6 fig, 7 tab, 3 append. DOE Contract DE-AC05-84OR21400.

Descriptors: *Groundwater quality, Water pollution control, Conductivity, Organic compounds, Wells, Statistical analysis, Tennessee, Radioactive waste disposal.

As required by Tennessee law, notification was given by Martin Marietta Energy Systems, Inc., Oak Ridge Gaseous Diffusion Plant (ORGDP) to the Department of Energy, Oak Ridge Operations, Environmental Protection Division, that several interim status surface impoundment groundwater monitoring wells showed statistically significant increases for the indicator parameters for groundwater contamination. Four downgradient wells at the K-1407-C surface impoundment indicated an increase in conductivity when compared with the upgradient background average; one of those wells also failed the statistical test when compared with itself. One downgradient well indicated the same type of increase at the K-1407-B surface impoundment. Additionally, one downgradient well at the K-1407-B impoundment indicated an increase in Total Organic Halogen (TOX) when compared with the background data for that well. Statistics that failed the required statistical test at the 0.01 level of significance during the semiannual sample event (April 28, 1987) and the verification resample (August 27, 1987), are compiled in a tabular format. The locations for the groundwater monitoring wells are illustrated. A false positive determination will be made for the conductivity increases and an off-site contamination determination will be made for the TOX. (Lantz-PTT)
W89-06644

ENVIRONMENTAL INFORMATION DOCUMENT: WASTE OIL BASINS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5E.
W89-06647

ANNUAL REPORT, 1985: NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM.
Interagency Task Force on Acid Precipitation, Washington, DC.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-138045. Price codes: A06 in paper copy, A01 in microfiche. 113p, 25 fig, 25 tab.

Descriptors: *Monitoring, *Air pollution effects, *Data acquisition, *Acid rain, *National Acid Precipitation Assessment Program, *Water pollution sources, Water pollution effects, Fate of pollutants, Water pollution control, Environmental effects, Aquatic environment, Federal jurisdiction.

The Federally-sponsored National Acid Precipitation Assessment Program (NAPAP) was conceived by Congress in late 1980 to develop and progressively refine the scientific understanding of the causes and effects of the complex atmospheric pollution problem commonly termed 'acid rain.' This understanding can form the basis for a rational control strategy and the design of viable techniques for mitigating any harmful effects. As required by law, this Annual Report to the President and Congress outlines the specific accomplishments of the National Program during 1985, provides a summary of selected factors in the state of relevant scientific knowledge, presents a list of publications produced under the aegis of the National Program, and describes the prospects for continued research progress. In 1985, the fourth full year of research under the National Program, activities have focuses on quantifying, testing, and reducing the uncertainties associated with concepts laid out during the first three years of the National Program. Additional efforts have been directed toward the development of new concepts, an activity made possible by improvements in scientific understanding. Specific accomplishments in the areas of: natural sources, man-made sources, atmospheric processes, deposition monitoring, aquatic effects, terrestrial effects, materials and cultural resources, and control technologies, are highlighted. (Lantz-PTT)
W89-06650

SUMMARY REPORT FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/ NATIONAL TRENDS NETWORK (NADP/NTN) SITE VISITATION PROGRAM: FOR THE PERIOD DECEMBER, 1984 THROUGH SEPTEMBER, 1986,
Research Triangle Inst., Research Triangle Park, NC.
W. C. Eaton, E. L. Tew, C. E. Moore, and D. A. Ward.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-132519. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/4-87/036, November 1987. 143p, 6 fig, 13 tab, 10 ref, 2 append. EPA Contracts 68-02-3767 and 68-02-4125.

Descriptors: *Air pollution effects, *Networks, *Acid rain, *Data collections, *Monitoring, *Data acquisition, Chemistry of precipitation, Sampling, Performance evaluation.

The proper collection of precipitation and the accurate measurement of its constituents are important steps in attaining a better understanding of the distribution and effects of 'acid rain' in the United States. This document is a summary report of the findings from the 1985-1986 Site Visitation Program to the 195 sites that comprise the National Atmospheric Deposition Program and National Trends Network precipitation networks, referred to collectively as the NADP/NTN network. Protocols and procedures followed in conducting the site visits are described. Results of systems and performance audits are discussed for siting, collection equipment, and the field support laboratories. Where exceptions are found, the potential effects of nonstandard siting, improperly operating equipment, and improper sample handling or analysis technique on the data base are discussed. Recommendations are given for improvement and standardization of individual sites and the network as a whole. (Lantz-PTT)
W89-06656

AQUATIC SURFACE MICROLAYER CONTAMINATION IN CHESAPEAKE BAY,
Battelle Pacific Northwest Labs., Sequim, WA. Marine Research Lab.
J. T. Hardy, E. A. Crecelius, L. D. Antrim, S. L. Kiesser, and V. L. Broadhurst.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-137443. Price codes: A03 in paper copy, A01 in microfiche. Report No. PPRP-100, June 1987. 43p, 5 fig, 7 tab, 67 ref. Maryland Department of Natural Resources Energy Administration Contract 2311206971.

Descriptors: *Air-water interface, *Chesapeake Bay, *Water pollution sources, Metals, Organic compounds, Ecological effects, Industrial wastewater, Aromatic compounds, Hydrocarbons, Alkanes, Potomac River, Gasoline, Monitoring.

The boundary between the atmosphere and the aquatic environment is an important biological habitat and a collection point for pollutants. The eggs and larvae of many fish and shellfish species float on, or come in contact with, the water surface throughout their early development. The aquatic surface microlayer (SMIC), approximately 50 micrometers thick, serves as a concentration point for metal and organic contaminants that have

low water solubility or are associated with floatable particles. Coal-fired power plants may release organic and metal contaminants into the environment that subsequently concentrate on the water surface. The objectives of this study were to: (1) determine the present degree of aquatic surface microlayer pollution at selected sites in Chesapeake Bay, and (2) provide a preliminary evaluation at sources (including power plants) contributing to any observed contamination. Twelve stations, located in urban bays, major rivers, and the north central bay, were sampled three times each at approximately 5-day intervals during May 1986. At all stations, concentrations of metals, alkanes, and aromatic hydrocarbons in the SMIC were high compared to the one bulkwater sample and to typical concentrations in water of Chesapeake Bay and elsewhere. SMIC contamination varied greatly among the three sampling times, but high mean contaminant levels (total PAHs, 1.9-6.2 micrograms/l, Pb 4.9-24 micrograms/L, Cu 4-16 micrograms/L, and Zn 34-59 micrograms/L) were found at the upper Potomac and northern bay sites. Suspected sources of surface contamination include gasoline and diesel combustion, coal combustion, and petroleum product releases. Concentration of metals and hydrocarbons found at approximately half the stations samples are sufficient to pose a threat to the reproductive stages of some fish and shellfish. (Lantz-PTT)
W89-06657

PHYSICS OF IMMISCIBLE FLOW IN POROUS MEDIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
J. C. Parker, R. J. Lenhard, and T. Kuppusamy.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-131008. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/2-87/101, November 1987. 141p, 45 fig, 12 tab, 85 ref.

Descriptors: *Immiscibility, *Soil contamination, *Model studies, *Path of pollutants, *Porous media, *Physical properties, Fluid mechanics, Permeability coefficient, Saturation, Pore size, *Model testing, Hydraulic models.

Conceptual formulation, numerical implementation and experimental validation of a model for the movement of organic chemicals which are introduced into soils as nonaqueous phase liquids via surface spills or leakage from subsurface containment facilities are addressed. Relationships between fluid pressures (P), saturations (S) and permeabilities (k) were developed. Relative permeability-saturation relations are predicted from the scaled S-P function, which is assumed to reflect the pore size distribution of the medium. Experimental studies were carried out to validate the constitutive model for cases involving monotonically draining water and total liquid saturation paths. Procedures were developed for the direct measurement of fluid pressures and saturations in three phase systems. Validation studies indicated the k-S-P model provides a reasonable description of the system behavior under the imposed experimental conditions and may be satisfactorily calibrated using relatively simple procedures. (Author's abstract)
W89-06658

MULTIMEDIA APPROACH TO RISK ASSESSMENT FOR CONTAMINATED SEDIMENTS IN A MARINE ENVIRONMENT,
Exposure Assessment Group, Office of Health and Environmental Assessment, Environmental Protection Agency, Washington, DC.
S. T. Hwang.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-133640. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/350, November 1987. 19p, 1 tab, 9 ref.

Descriptors: *Risk assessment, *Marine sediments, *Marine environment, Water pollution effects, *Path of pollutants, Estuaries, Model studies, Dredging, Population exposure, Cleanup operations.

Problems of contaminated sediments frequently occur in dealing with exposure evaluation for rivers, lakes, estuaries, and harbors. These sites represent a special type of Superfund site. Contaminated aquatic sediments can lead to significant risk to humans resulting from exposure to contaminants through multimedia pathways such as ingestion, dermal absorption, and inhalation. This paper examines risk assessment approaches for these pathways under different conditions, and predictive models for estimating the ambient air concentrations. Exposure assessment methodologies are also described. Models useful in estimating volatilization rates from contaminated areas are presented for cases corresponding to high tide, low tide, and mud flats, and should help evaluate the population exposure effected by inhalation during implementation of no action or remedial action alternatives. Remedial options considered are: in-situ containment, clamshell dredging, and hydraulic dredging. (Lantz-PTT)
W89-06660

ENVIRONMENTAL INFORMATION DOCUMENT: HYDROFLUORIC ACID SPILL AREA,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
L. A. Huber, and H. W. Bledsoe.
Available from National Technical Information Service, Springfield, VA 22161, as DE88-001369. Price codes: A04 in paper copy, A01 in microfiche. Report No. DPST--85-696, March 1987. 92p, 14 fig, 34 tab, 30 ref, append. DOE Contract AC09-76R00001.

Descriptors: *Hydrofluoric acid, *Waste treatment, *Path of pollutants, *Water pollution treatment, *Environmental effects, *Cleanup operations, Risk, Water quality, Wildlife, Savannah River Plant, Waste disposal, Lead, Fluoride, Economic aspects, Costs, Ecological effects.

The Hydrofluoric Acid Spill Area is located in the Central Shops Area of the Savannah River Plant (SRP). The site is identified by a sign indicating the presence of a contaminated area. It is uncertain if a spill occurred at this site or if contaminated soil containers were buried here. Soil cores from the Hydrofluoric Acid Spill Area have not been collected or analyzed. Four groundwater monitoring wells were installed around the spill area in 1984 and have been sampled quarterly since early 1985. The potential impacts of lead and fluoride were assessed because of their measured groundwater concentrations, even though there is no statistical difference between the levels in the upgradient and downgradient wells for these constituents. The closure options considered for the Hydrofluoric Acid Spill Area are waste removal and closure, no waste removal and closure, and no action. An evaluation of environmental impacts indicates that the relative risk to human health and ecosystems for the closure options analyzed is low. The ecological assessment shows that the effects of any closure activities on river water quality and wildlife would be insignificant. The cost estimates show that the waste removal and closure option is the most expensive ($890,000). The other two options are a factor of 8 less expensive. (Lantz-PTT)
W89-06670

NUMERICAL MODEL FOR THREE-DIMENSIONAL HYDRODYNAMIC TRANSPORT: DOCUMENTATION OF THE COMPUTER PROGRAM,
Environmental Research Lab., Narragansett, RI.
J. F. Paul, and J. A. Nocito.
Available from National Technical Information Service, Springfield, VA 22161, as PB88-126420. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/3-87/043, November 1987. 153p, 37 fig, 23 tab.

Descriptors: *Mathematical models, *Flow, *Documentation, *Hydrodynamics, *Computer programs, *Path of pollutants, *Plumes, Thermodynamics, Lakes, Mathematical equations, Lake Erie, Fluid dynamics, Flow profiles, Thermal pollution, Hydraulic geometry, Rivers, Bays, Coastal waters.

Since the early 1970s, the development and application of a hydrodynamic model for time-dependent, three-dimensional, variable-density, and variable-temperature flow in lakes, rivers, embayments, nearshore coastal areas, and riverine and thermal discharge plumes has been conducted by the U.S. EPA through the Large Lakes Research Station (LLRS) at Grosse Ile, Michigan. In concert with the effort on this hydrodynamic model, work has been ongoing with a compatible physical transport model. The physical transport model has been applied to a variety of calculations in the Great Lakes and to freshwater and marine systems around the world. The model is formulated from the time-dependent convective-diffusive equation, and is designed to be compatible with the time-dependent hydrodynamic model documented in a separate set of reports. The emphasis of this report is on the details of the computer program to provide instruction to the prospective user on how to apply the model, incorporate any modifications needed for a specific application, and perform calculations. Three case studies are presented to illustrate various options available with the model: Lake Erie 5 km grid, square isothermal lake, and surface thermal discharge. The Lake Erie and square isothermal lake examples illustrate application to completely enclosed water bodies, with the Lake Erie case including river inflows and outflows. The square lake is an example with very simplified geometry, while the Lake Erie example has complicated geometry including islands. The thermal discharge provides an example with open water boundaries, as would be used in nearshore coastal applications. This example also illustrates the complex time-dependent, 3-D calculations that can be conducted. Specific sections of the report include the following: background of the model, including examples of where it has been applied and how it may be applied; an overview of the computer program structure and the philosophy inherent in the structure; the input required to run the model; the output that the model generates, in both printed and graphic form; and the details of the three case studies. (Lantz-PTT)
W89-06675

ENVIRONMENTAL INFORMATION DOCUMENT: BURNING/RUBBLE PITS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
L. A. Huber, W. F. Johnson, and I. W. Marine.
Available from National Technical Information Service, Springfield, VA 22161, as DE88-001370. Price codes: A10 in paper copy, A01 in microfiche. Report No. DPST--85-690, March 1987. 237p, 35 fig, 47 tab, 38 ref, 2 append. DOE Contract DE-AC09-76SR00001.

Descriptors: *Incineration, *Waste dumps, *Cleanup operations, *Path of pollutants, *Environmental effects, Waste treatment, Ecological effects, Economic aspects, Costs, Fate of pollutants, Groundwater pollution, Observation wells, Risk, Water quality, Wildlife, Savannah River Plant, Statistical analysis.

The Burning/Rubble Pits, located near each of the major operating areas at the Savannah River Plant (SRP), began collecting burnable waste in 1951. In 1973, when the procedure of burning waste ceased, the pits were converted to receive rubble only. As each rubble pit reached its capacity, it was backfilled and considered closed. No soil cores from the Burning/Rubble Pits have been analyzed. There are four groundwater monitoring wells located around each of the pits. These wells have been sampled quarterly since 1984. A statistical analysis of monitoring data indicates elevated levels of certain inorganic and organic chemicals in the groundwater at several of the Burning/Rubble Pits. The closure options considered for the Burning/Rubble Pits are waste removal and closure, no waste removal and closure, and no action. An evaluation of the environmental impacts from the Burning/Rubble Pits indicates that the relative risks to human health and ecosystems for the postulated closure options are low. The ecological assessment shows that the effects of any closure activities on river water quality and wildlife would be insignificant. The cost estimates show the waste removal and closure option to be the most expensive for all of the pits. The average cost for the

waste removal and closure option is $8,700,000. The other closure options are less expensive by up to 1 to 2 orders of magnitude for the no action option. (Lantz-PTT)
W89-06676

REVERSIBILITY OF ACIDIFICATION.
For primary bibliographic entry see Field 5G.
W89-06680

RAIN PROJECT: RESULTS AFTER 2 YEARS OF TREATMENT,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 5G.
W89-06682

SOME ASPECTS OF THE CHEMICAL SPECIATION OF ALUMINIUM IN ACID SURFACE WATERS,
Freshwater Biological Association, Ambleside (England).
E. Tipping, and C. A. Backes.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 30-33. 9 ref.

Descriptors: *Acid rain effects, *Chemical analysis, *Aluminum, *Acidic water, *Surface water, *Chemical speciation, Inorganic compounds, Organic compounds, Metal complexes, Polymers, Hydrolysis, Reagents, Kinetics, Prediction.

Aluminum in acid waters exists in a number of forms. The distribution of the metal among monomeric inorganic species can be calculated using established equilibrium constants. The determination and prediction of concentrations of organic monomeric Al and polymeric hydrolyzed Al are more difficult. A reasonably satisfactory approach to the determination of the speciation of monomeric Al is the estimation of inorganic Al by difference. Caution is urged, however, in applying this approach to samples with a high proportion of the Al in an organically-complexed form. It might well be advisable to apply a correction of 20% to estimates of organic Al. Kinetic analysis, using either a 'mixed reagent' consisting of hydroxyquinoline sulfonate and sodium fluoride or acid dissolution coupled with an appropriate analytical technique for monomeric Al, offers promise for the detection and quantification of polymeric hydrolysis products of Al. The application of Al/organic complexation models appears to be useful in checking determinations of Al speciation and in predicting trends in speciation. (See also W89-06680) (Shidler-PTT)
W89-06683

MODELLING REVERSIBILITY OF ACIDIFICATION WITH MATHEMATICAL MODELS,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W89-06692

MODELLING STREAM ACIDITY IN U.K. CATCHMENTS,
Institute of Hydrology, Wallingford (England).
P. G. Whitehead, C. Neal, and R. Neale.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 126-141. 8 fig, 27 ref.

Descriptors: *Acidic streams, *Catchment areas, *Acid rain effects, *Model studies, *Scotland, *Wales, Reforestation, Hydrologic data collections, Mathematical models, Time series analysis, Multivariate analysis, Prediction, Water pollution sources, Industrial wastes, Acidic soils.

As part of the joint British/Scandinavian Surface Waters Acidification Programme, the Institute of Hydrology (IH) is establishing catchment studies in Scotland and Wales. Data from these catchment studies are being used to develop a range of models for investigating short-term and long-term changes in catchment acidity. A wide range of mathematical modeling techniques is available at IH for analyzing catchment data. These include CAPTAIN (Computer Aided Package for Time Series Analysis and the Identification of Noisy Systems), MIV (Multivariable Time-Series Model), the BIRKENES model, MAGIC, EKF (Extended Kalman Filter), TOPMODEL, and IHDM (Institute of Hydrology Distributed Model). They provide examples of how both acidic deposition and conifer afforestation can increase streamwater acidity. Long-term trends are predicted. For example, the long-term trends in stream-water acidification for a grassland catchment suggest that for at least part of the upland UK, acidic-oxide pollutant inputs are the dominant source of increased stream-water acidity. Much of the British uplands have soils which are susceptible to acidic inputs; it is therefore reasonable to assume the results of this present modeling exercise are widely applicable. A 50% reduction in current industrial emissions is required to prevent further increase in stream acidity in moorlands. (See also W89-06680) (Shidler-PTT)
W89-06693

TESTING A SOIL-ORIENTED CHARGE BALANCE EQUILIBRIUM MODEL FOR FRESHWATER ACIDIFICATION,
Senter for Industriforskning, Oslo (Norway).
N. Christophersen, M. Johannessen, and R. Skaane.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 142-148. 2 fig, 9 ref.

Descriptors: *Model testing, *Soil chemistry, *Equilibrium, *Acidic water, *Acid rain effects, Model testing, Prediction, Ion exchange, Aluminum, Low flow, Norway.

There exist several different approaches for modeling effects of acid deposition on freshwater chemistry. However, all models need more thorough checking against observations to improve confidence in predictions of future freshwater chemistry following changes in deposition. Data from seven catchments in the Fyresdal/Nissedal area, southern Norway, were used to test assumptions in the so-called soil-oriented charge-balance approach. Important processes here include ion exchange, aluminum-mineral dissolution, and the carbon dioxide/bicarbonate system. These processes form part of models like ILWAS, MAGIC, and BIRKENES. Excluding samples from extended low-flow periods, theory predicted observations fairly well for streams that were not lake outflows. In the latter case the observations showed more scatter. (See also W89-06680) (Author's abstract)
W89-06694

EVIDENCE OF STREAM ACIDIFICATION IN DENMARK AS CAUSED BY ACID DEPOSITION,
Miljoestyrelsen, Silkeborg (Denmark). Freshwater Lab.
A. Rebsdorf, and N. Thyssen.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 165-168. 3 fig, 2 ref.

Descriptors: *Acidification, *Acid streams, *Acid rain effects, *Water pollution sources, *Denmark, Alkalinity, Hydrogen ion concentration, Agricultural watersheds, Fertilizers, Agricultural chemicals.

Some years ago a study of oligotrophic seepage lakes in Denmark demonstrated a tendency towards acidification; this was thought to be caused mainly by the atmospheric deposition of acidifying substances. Alkalinity and pH data (1977-1985) from small streams in two areas in central and western Jutland indicated that stream waters in some of the sandy areas are also undergoing an acidifying process, due probably to atmospheric deposition. One of the catchment areas consists partly of arable land; in this case, an additional cause of acidification might be ammonia fertilization of the soil. (See also W89-06680) (Author's abstract)
W89-06697

CHEMICAL AND BIOLOGICAL CHARACTERIZATION OF MUNICIPAL SLUDGES, SEDIMENTS, DREDGE SPOILS, AND DRILLING MUDS.
For primary bibliographic entry see Field 5D.
W89-06705

CHARACTERIZATION OF TRACE METAL ASSOCIATIONS WITH POLLUTED MARINE SEDIMENTS BY SELECTIVE EXTRACTIONS,
Science Applications International Corp., Narragansett, RI.
For primary bibliographic entry see Field 5A.
W89-06715

TOTAL, EXTRACTABLE, AND LEACHABLE ORGANIC HALIDES IN SOIL AND SEDIMENTS,
Rosemount Analytical Div.-Dohrmann, Santa Clara, CA.
For primary bibliographic entry see Field 5A.
W89-06723

ORGANIC MICROPOLLUTANTS IN THE AQUATIC ENVIRONMENT: PROCEEDINGS OF THE FIFTH EUROPEAN SYMPOSIUM, HELD IN ROME, ITALY, OCTOBER 20-22, 1987.
For primary bibliographic entry see Field 5A.
W89-06748

PESTICIDE MICROPOLLUTANTS IN LAKE ALBUFERA (SPAIN),
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
J. M. Carrasco.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 59-61. 5 ref.

Descriptors: *Lake restoration, *Lakes, *Spain, *Pesticides, *Path of pollutants, *Water pollution, *Pollutant identification, *Sublethal levels, Population exposure, Aquatic environment, Industrial wastes, Seasonal variation, Urban runoff, Fish populations, Population dynamics, Population exposure, Agricultural runoff, Halogenated pesticides, Organophosphorus pesticides.

The pollution of Lake Albufera (Spain) by pesticides was studied to determine the hazards involved in the pesticide treatment of a nearby rice field and forest and in general urban and industrial contamination. Molinate, benthiocarb and fenitrothion are the pesticides that have been found to reach the highest concentrations in waters from the lake. DDT and BHC were the most frequently detected organolchlorinated pesticides in this ecosystem. These levels were always below those considered lethal to fish and birds. It was also found that the organophosphate insecticide contamination was seasonal. The herbicides molinate and benthiocarb did not reach levels that were lethal to fish. When pesticide levels were reduced, the repopulation of the sensitive organisms in the lake was achieved. (See also W89-06748) (Friedmann-PTT)
W89-06755

PCBS AND ORGANOCHLORINE PESTICIDES IN EEL AND FLOUNDER IN THE TAGUS ESTUARY,
Instituto Hidrografico, Lisbon (Portugal).
M.J. Benoliel, and M. L. Shirley.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 83-87. 1 fig, 3 tab, 6 ref.

Descriptors: *DDT, *Bioaccumulation, *Path of pollutants, *Pesticides, *Organic pesticides, *Eel, *Flounders, Population exposure, Fish populations, *Estuaries, Fish physiology, Fertilizers, Polychlorinated biphenyls, Sampling, Industrial wastes, Quantitative analysis, Bioaccumulation, Portugal, Pollutant identification, Halogenated pesticides.

Within the Tagus estuary (Portugal), in the vicinity of an industrial zone (chloroalkyl, pesticides, fertilizers and steelworks plants) a monitoring program on Organochlorine Pesticides and Polychlorinated Biphenyls has been carried out since 1983. This zone is also influenced by agricultural activities. Flounder (Platichthys flesus) and eel (Anguilla anguilla) have been sampled twice a year. Analyses were carried out both of the liver and fillet. For the PCB quantification, 13 congeners were used, their contribution to the total amount of PCBs being about 40-50%. Special attention was focused on the so-called indicator congeners IUPAC No. 28, 52, 101, 138, and 153. Low concentrations of both compounds were observed, which did not pose a risk to the two species analyzed nor to public health. In eel liver, the 153 congener showed a higher accumulation (42-125 micrograms/Kg wet weight) than the 138 one (13-40 micrograms/Kg wet weight). In flounder liver, PCBs 101, 138 and 153 presented a decrease of five times their concentrations during the period 1984-1986. PCBs 28 and 52 showed no significant variations during the same period. 44' DDT levels were less than 10% of the total DDT, probably due to the fact that DDT has not been used in Portugal since 1970. Ratios of 44' DDT/total DDT were smaller in liver than in fillet both in eel and flounder. (See also W89-06748) (Friedmann-PTT)
W89-06759

EVALUATION OF DEGREE OF POLLUTION OF TIBER AND ANIENE RIVERS BY NITRILOTRIACETIC ACID,
Rome Univ. (Italy). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-06765

HYDROCARBONS IN EAST MEDITERRANEAN SEA: DETERMINATION AND OCCURRENCE IN THE SEDIMENT OF CONSIDERED POLLUTED AND UNPOLLUTED AREAS OF COASTAL ENVIRONMENT,
Crete Univ., Iraklion (Greece). Lab. for Environmental Chemistry.
M. Psathaki, M. Zourari, and E. Stephanou.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 121-126. 2 fig, 3 tab, 6 ref.

Descriptors: *Hydrocarbons, *Oil pollution, *Water quality, *Sediments, *Coastal water, *Mediterranean Sea, *Water pollution sources, Sampling, Quantitative analysis, Biodegradation, Petroleum products, Pollutant identification, Greece.

Sediments collected from Iraklion Gulf and Chania Gulf (North Crete) were analyzed to assess the status of anthropogenic hydrocarbon input. Aliphatic, aromatic hydrocarbons and molecular markers such as sterane and hopane-type compounds were determined, by GC and GC/MS, for source identificaiton. Three sampling stations, distributed among the two gulfs, were selected for analysis. The polluted nature of the sediments of the three stations was evidenced by the saturated aliphatic hydrocarbon distribution which, although still dominated by biogenically derived natural hydrocarbons, showed a slight baseline hump of unresolved components characteristic of oil-polluted sediments. Important confirmation of petroleum contamination was obtained from mass fragmentograms. This was indicative of petroleum contributions to the sediments. No important biodegradation was noted in the aliphatic composition of the hydrocarbons found in the Iraklion gulf sediments. This may be explained by the continuous input of petroleum products near the electricity plant near station 1 and the harbor (station 2). (See also W89-06748) (Friedmann-PTT)
W89-06766

SANDOZ ACCIDENT,
Amt fuer Umiveltschutz und Energie, Kantons Basel-Landschaft, Liestal, Switzerland.
B. Hurni.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 128-131.

Descriptors: *Water pollution sources, *Accidents, *Path of pollutants, *Groundwater pollution, *Soil contamination, *Pesticides, *Air pollution, *Agricultural chemicals, Runoff, Aquatic plants, Clean-up operations, Stream pollution, Rainwater, Plumes, Rhine River, Switzerland.

The cause, course of events, and consequences of the Sandoz warehouse fire, Schweizerhalle, Switzerland, on 1st November 1986, are presented. The flux of matter to the atmosphere, to the soil, to the groundwater, and to the Rhine River are discussed, and the chemicals released to the environment are characterized. 1350 tons of agricultural chemicals were stored in the warehouse, mainly phosphoric acid ester-insecticides and urea. Also in storage were 8.6 tons of an aqueous concentrate of mercury compound, 1.5 tons of phenyl mercury acetate, 2 tons of the highly chlorinated insecticide Endosulfan, 2.3 tons of the acaricide Tetradifon, and 2.4 tons of intensive fluorescent dye. Under the effect of heat, water and oxygen, part of the stored agricultural chemicals underwent changes during the fire through thermolysis, pyrolysis or hydrolysis. Convection currents in the air above the fire transported an unmeasurable amount of the substances to a height of 600-800 m above ground. A southeast wind carried the products towards Basle City. Some of it was collected by the rainwater run-off drainage system and went directly into the Rhine River. Some of it seeped underground, contaminating the soil and underlying groundwater at a depth of 14 m. More than 10 tons of agricultural chemical substances entered into the Rhine River. Extensive damage to the local aquatic fauna resulted. A large-scale clean-up effort ensued, and the recolonization of the Rhine River is progressing well, and will take several years more. (See also W89-06748) (Friedmann-PTT)
W89-06767

PREDICTING TRANSPORT BEHAVIOR OF ORGANIC POLLUTANTS USING SIMPLE MATHEMATICAL MODELS,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
For primary bibliographic entry see Field 7C.
W89-06769

FATE AND TRANSPORT OF ORGANIC COMPOUNDS IN RIVERS. 1: SELECTION OF STUDY SITE AND VALIDATION OF SAMPLING AND ANALYTICAL PROCEDURES,
Water Research Centre, Medmenham (England). Medmenham Lab.
C. D. Watts, and K. Moore.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 154-168. 2 fig, 5 tab, 23 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Organic compounds, *Sampling, *Water analysis, *Stream pollution, Quantitative analysis, Suspended load, Particulate matter, On-site data collections, Gas chromatography, Spectrometers.

A study of the transport and fate of organic pollutants in rivers has been initiated by the selection of a site for study from among seven candidate sites. Analysis was carried out on the water, suspended particulates and sediments at the selected site to assess the representativeness of the sampling procedures and determine a range of compounds suitable for the detailed transport and fate study. The selected compounds were mostly anthropogenic in origin and included several potential EC list 1 and related chemicals. Calculations were carried out to determine the analytical requirements for the detailed study and the proposed research program is outlined. Gas chromatography and mass spectrometry were used to asses total organic carbon, the organic carbon, hydrogen and nitrogen content of sediment and suspended particles, and analyze chloride and boron. The site selected for detailed study is very nearly ideal, with a major point source (sewage treatment works effluent) contributing one-third of the downstream flow and no major downstream organic inputs for a distance of nearly 10 km. A wide range of pollutants are present in the effluent, and the physicochemical properties of the selected pollutants cover a broad range with Octanol/water partition coefficients from about 3 to 11. (See also W89-06748) (Friedmann-PTT)
W89-06770

SEDIMENT-WATER PARTITION COEFFICIENTS OF HYDROPHOBIC CHEMICALS IN THE PRESENCE OF THIRD PHASE MATERIAL,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
S. Marca Schrap, and A. Opperhuizen.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 170-175. 1 fig, 1 tab, 7 ref.

Descriptors: *Fate of pollutants, *Path of pollutants, *Sediment-water interfaces, *Solubility, *Benzenes, *Organic compounds, *Sorption, Chemical properties.

Aqueous solubilities of three chlorobenzenes in sediment-water systems are significantly enhanced by the presence of third phase material originating from the sediment. Because the aqueous concentrations of the chlorobenzenes are influenced by this third phase material, their sorption coefficients will also be influenced. Besides the experimental conditions, the characteristics of the sediment determine the third phase concentration. Pretreatment of the sediment, such as drying in an oven, can change these characteristics significantly. Therefore, sediment-water partition coefficients determined with differently-treated sediments may not be comparable, even when the same sediment and the same separation techniques are used. (See also W89-06748) (Friedmann-PTT)
W89-06771

ENVIRONMENTAL FATE OF ORGANOSILICON CHEMICALS,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
A. Opperhuizen, G. M. Asyee, and J. R. Parsons.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 176-183. 38 ref.

Descriptors: *Fate of pollutants, *Organic compounds, *Chemical wastes, *Silicon, *Bioaccumulation, Aquatic environment, Sampling, Solubility, Path of pollutants.

In abiotic samples obtained from the natural aquatic environment, evidence has been reported for the presence of silicones from anthropogenic sources. It has also been reported, however, that abiotic transformation may play an important role in the environmental fate of these chemicals. In particular, clay-catalyzed hydrolysis may be important. Little has been known about the ability of microorganisms to transform silicon compounds. Since most organosilicon compounds are chemicals with very low aqueous solubilities and high solubilities in organic solvents, it was expected that these chemicals would accumulate to high concentrations in organisms. This is not what has been found in laboratory tests with fish or mammals, or in biota sampled in the natural environment. The low bioaccumulation factors may be explained by high rates of elimination of the short chain silicones and by a lack of uptake for the long-chain chemicals. (See also W89-06748) (Author's abstract)
W89-06772

POLLUTION OF SARONICOS GULF (ATHENS, GREECE) BY FOSSIL FUEL HYDROCARBONS,
NRC Democritos, Athens (Greece).
For primary bibliographic entry see Field 5A.
W89-06773

SANDOZ/RHINE ACCIDENT,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
P. D. Capel, and W. Giger.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 189-194. 1 fig, 1 tab, 9 ref.

Descriptors: *Accidents, *Rhine River, *Pesticides, *Water pollution effects, *Stream pollution, *Path of pollutants, *Fate of pollutants, Quantitative analysis, Model studies, Monitoring, Mercury, Chemical analysis, Water analysis, Population exposure.

On 1 Nov 1986, a fire at a Sandoz warehouse in Switzerland resulted in a massive input of chemicals to the atmosphere, Rhine River and surrounding soils. The wave of chemicals in the river, predominately disulfoton and thiometon, was monitored as it traveled to the North Sea. This chemical wave resulted in the death of benthic organisms and fish, especially eels. From the measured and estimated concentrations, etrimfos, endosulfan and formothion were probably lethal chemicals. The measured water concentrations from the period directly following the accident suggest that some of the chemicals were lost from the main wave before it reached the North Sea. Based on physical, chemical and biological properties of the pesticides and the hydraulic characteristics of the Rhine, the fate and transport of the chemicals have been modeled. It is predicted that most were quickly flushed from the river. The exceptions are the mercury compounds and possibly endosulfan. Other than these, there should be no residual of the chemicals in the water, sediment or biota. (See also W89-06748) (Author's abstract)
W89-06774

OCCURRENCE AND LEACHING OF PESTICIDES IN WATERS DRAINING FROM AGRICULTURAL LAND,
National Board of Waters, Helsinki (Finland).
S. Rekolainen.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 195-197. 4 tab, 4 ref.

Descriptors: *Water pollution sources, *Leaching, *Pesticides, *Organic pesticides, *Path of pollutants, *Herbicides, *Agricultural runoff, Trace elements, Toxicity, Water pollution effects, Drainage area, Runoff, Sampling, Finland.

The occurrence and leaching of some widely used pesticides was studied in 1985-1987 in an experimental field, a small agricultural drainage basin and in a river in Finland highly loaded by agricultural runoff. Phenoxy herbicides were found in most of the samples, with the highest concentrations being measured in mid-summer, soon after application. High concentrations were usually associated with heavy rainfall events. Trace amounts of some highly toxic insecticides could also be detected in the same samples. Also, in spite of the relatively high degradation rate of the organic phosphorus insecticides dimethoate and fenitrothion, trace amounts of these compounds were detected in some runoff samples. Because of their high acute toxicity, they may have some direct effects on aquatic ecosystems. (See also W89-06748) (Author's abstract)
W89-06775

POLYCHLORINATED BIPHENYLS IN THE KUPA RIVER, CROATIA, YUGOSLAVIA,
Sisak Medical Center (Yugoslavia). Dept. of Sanitary Chemistry.
Z. Smit, V. Drevenkar, and M. Kodric Smit.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 198-203. 1 fig, 1 tab, 7 ref.

Descriptors: *Bioaccumulation, *Polychlorinated biphenyls, *Kupa River, *Yugoslavia, *Organic compounds, *Stream pollution, Fish populations, Population exposure, Sampling, Pollutant identification, Sediment sampler, Suspended load, Particulate matter, Aquatic environment, Path of pollutants, Water pollution sources.

The presence of polychlorinated biphenyls (PCBs) was investigated in samples of water, suspended particles, sediments and fish from the Kupa river, Croatia, Yugoslavia, along a river stretch extending up to 10 km upstream and 200 km downstream of the primary contaminated karst region. The PCB levels detected in the samples collected downstream ranged from 1 to 52 ng/cu dm for water, from 50 to 190 micrograms/kg for suspended particles and from 8 to 39 micrograms/kg for the sediment. A wide range of PCB concentrations, from 0.1 to 42.3 micrograms/g, which were measured in edible portions of different fish, confirmed a long-term contamination of the river with PCBs. As the Kupa river may be classified among low to moderately contaminated waters, it is essential that the investigations of the presence and behavior of PCBs in the river and its environment be continued. (See also W89-06748) (Author's abstract)
W89-06776

BIODEGRADATION OF CHLORINATED AROMATIC CHEMICALS IN CONTINUOUS CULTURES,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
For primary bibliographic entry see Field 7B.
W89-06777

ANAEROBIC DEGRADATION, PROCESSES AND TEST METHODS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Microbiology.
G. Schraa.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 215-227. 2 fig, 1 tab, 51 ref.

Descriptors: *Fate of pollutants, *Wastewater treatment, *Biodegradation, *Anaerobic conditions, *Anaerobic digestion, *Organic compounds, Chemical properties, Metabolism, Testing procedures.

Several aspects of the anaerobic biodegradation of organic compounds are presented. The role of molecular oxygen in the metabolism of organic carbon compounds is summarized, followed by a discussion of some of the pathways and the electron acceptors involved in the degradation under anaerobic conditions, among them aerobic metabolism, denitrification, fermentation, sulfate reduction, and methanogenesis. Several degradation mechanisms are demonstrated for selected aliphatic and aromatic xenobiotic compounds. Examples are given of factors that will strongly influence the degradation of anthropogenic substances. Finally, existing methods for biodegradability testing, their limitations, and some suggestions for improvements are described. (See also W89-06748) (Author's abstract)
W89-06778

FATE OF ORGANIC COMPOUNDS IN THE ENVIRONMENT,
Swedish Environmental Research Inst., Stockholm.
A. H. Neilson, A. S. Allard, C. Lindgren, and M. Remberger.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 228-235. 2 fig, 2 tab, 12 ref.

Descriptors: *Path of pollutants, *Fate of pollutants, *Organic compounds, Aquatic environment, Pollutant identification, Laboratories, Sediments.

An account is given of microbiological procedures for investigating the fate of xenobiotics discharged into the aquatic environment. A brief account is given of the experimental procedures that have been developed, and their application is exemplified from the results of experiments with chlorogualiacols and related compounds. Experiments encompass both aerobic and anaerobic transformation, and emphasis is placed on environmental factors of significance in determining the outcome of laboratory experiments . An attempt was made to assess the environmental relevance of the data acquired by carrying out experiments in which natural sediment samples were spiked with the xenobiotics. Attention is directed to the significant role of binding to sediments. (See also W89-06748) (Author's abstract)
W89-06779

TEST METHODS AND STRATEGIES FOR ENVIRONMENTAL MANAGEMENT PURPOSES - ENVIRONMENTAL FATE TESTING OF CHEMICALS AND EFFLUENTS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 5G.
W89-06782

EVALUATION OF SOME CHEMICAL FATE AND TRANSPORT MODELS. A CASE STUDY ON THE POLLUTION OF THE NORRSUNDET BAY (SWEDEN),
Senter for Industriforskning, Oslo (Norway).
K. Kolset, B. F. Aschjem, N. Christophersen, A. Heiberg, and B. Vigerust.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 372-386. 3 fig, 9 tab, 21 ref.

Descriptors: *Model studies, *Mathematical models, *Path of pollutants, *Fate of pollutants, *Sweden, *Case studies, Aquatic environment, Organic compounds, Water pollution, Marine environment, Norrsundet Bay.

Mathematical models in the marine environment can be grouped into several classes. These models may be split into physical, chemical and toxicological domains. They may also be classified by their geographical extension, their accuracy and/or amount of input data needed. The main classes of these models are discussed. Three different models were used to investigate transport and fate of chemicals in the aquatic environment. The models FEQUM, EXAMS and QWASI are presented, their characteristics explained and compared. The three models have been applied to the Norrsundet area (Sweden). Norrsundet is a heavily polluted bay on the east coast of the country. The models were calibrated using data on chloroform in wastewater, and tested on four chlorophenolics. All the models gave satisfactory results for the compounds investigated except for tetrachlorocatechol. Correlation coefficients between calculated and measured concentrations vary from 0.86 to 0.97. The results obtained for tetrachlorocatechol are probably due to its oxidation of TeCC before reaching the first compartment. (See also W89-06748) (Author's abstract)
W89-06796

MODELING OF GROUNDWATER TRANSPORT OF MICROORGANIC POLLUTANTS: STATE-OF-THE-ART,
Vrije Univ., Brussels (Belgium). Lab. of Hydrology.
F. De Smedt.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987.

Kluwer Academic Publishers, Boston, MA. 1988. p 387-400. 7 fig, 2 tab, 34 ref.

Descriptors: *Organic compounds, *Model studies, *Groundwater pollution, *Path of pollutants, *Halogens, *Hydrocarbons, Immisibility, Sulfur, Nitrogen, Hydrodynamics, Groundwater hydrology, Sorption, Biodegradation, Plumes.

Some basic concepts and recent achievements in the modeling of transport of organic substances in groundwater are reviewed. Contaminants reviewed include hydrocarbons, compounds containing oxygen, halogenated compounds, compounds containing nitrogen and those containing sulfur. General, advective and hydrodynamic dispersion are reviewed. Immiscible transport and transport numerical modeling are discussed. Organic pollutants are subjected to complex physical, chemical and biological transformations while moving through the groundwater layers, making it difficult to understand and account for all the processes involved; consequently, the study of this subject becomes an interdisciplinary field of research. A large number of new developments have emerged giving new insight into processes such as hydrodynamic dispersion, sorption, biodegradation and immiscible flow. It is concluded that considerable work has been done with respect to modeling of organic pollutant transport in groundwater, but a need for further developments remains necessary in order to put an effective stop to the very serious deterioration of the groundwater reserves. (See also W89-06748) (Author's abstract)
W89-06797

MODELING OF SURFACTANTS IN THE COMUNIDAD DE MADRID AS SUBBASIN OF TAGUS RIVER,
Comunidad de Madrid (Spain). Models and Technology Div.
F. Cubillo.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 402-407. 4 fig, 2 ref.

Descriptors: *Fate of pollutants, *Model studies, *Path of pollutants, *Stream pollution, *Surfactants, *Spain, *Water quality, *Water treatment, Wastewater treatment, Decisions, Geomorphology, Geohydrology, Urban water, Channel morphology, Reservoirs, Hydrologic models, Simulation.

The need to have accurate knowledge about concentrations, fate and exposure of surfactants in the Comunidad de Madrid rivers led to the development of a water quality model that was able to simulate the behavior of some of these surfactants. This model has been used mainly in two ways, for improving knowledge and for selecting the correct type of water treatment plant for meeting the water quality goals planned for the area's surface waters. Basic inputs into the model included sources of surfactant wastes, point loads from urban zones and industries, basin and river bed geomorphology, hydrology, climatology and hydraulic characteristics of the area, outflows, reservoir and canal operation principles, canal and irrigation zones, and existing historical data of linear alkylbenzene sulfonate (L.A.S.). The computer program used was deterministic, simulative, steady-state and one-dimensional, based on the well-known QUAL2E program. In addition to the normal constituents in water quality studies, the model has been used in studies of anionic surfactant and L.A.S. Once the model was developed, it was used to predict the final concentrations of L.A.S. relative to those levels necessary to avoid the appearance of foam in undesirable places. (See also W89-06748) (Friedmann-PTT)
W89-06798

MODELING OF ANTHROPOGENIC SUBSTANCES IN AQUATIC SYSTEMS: MASAS - A PERSONAL COMPUTER APPROACH,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).

For primary bibliographic entry see Field 7C.
W89-06799

QUANTITY AND QUALITY OF URBAN RUNOFF FROM THE CHESTER CREEK BASIN, ANCHORAGE, ALASKA,
Geological Survey, Anchorage, AK. Water Resources Div.
T. P. Brabets.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4312, 1987. 58p, 35 fig, 38 tab, 13 ref.

Descriptors: *Urban runoff, *Water pollution sources, *Water quality, *Chester Creek, *Anchorage, *Alaska, Model studies, Computer models, Simulation analysis, Anchorage, Alaska, Coliforms, Bacteria, Lead, Trace metals, Suspended sediments, Precipitation, Seasonal variation, Calibrations, Fate of pollutants, Data interpretation.

Urbanization has affected both the flow characteristics and water quality of streams in the Chester Creek basin, of Anchorage, Alaska. Peak flows are higher in the urban rather than rural parts of the basin, and the percent of effective impervious area has a significant effect on storm runoff volumes and peaks. Water quality in the Chester Creek basin varies according to season and flow conditions. During low or base-flow conditions, concentrations of most water quality constituents measured are within State of Alaska drinking water standards, except for fecal coliform bacteria. During periods of high flow due to snowmelt or rainfall, concentrations of trace metal lead usually exceed recommended maximum levels. The primary sources of trace metal lead and suspended sediments are commercial areas, while the primary source of nutrients and fecal coliform bacteria is residential areas. Streamflow and water quality data collected at five sites representing different land-use categories were used to calibrate and verify three U.S. Geological Survey computer-based models: the Distributed Routing Rainfall-Runoff Model-Version II (DR3M-II), the Multi-Event Urban Runoff Quality Model (DR3M-QUAL), and the Precipitation Runoff Modeling Systems (PRMS). The PRMS can be used to simulate the effects of increased urbanization on daily flows. The DR3M-II can be used to simulate storm effects on small basins of < 40 acres. The DR3M-QUAL can be used to estimate seasonal loads of suspended sediment from basins of < 40 acres. (Lantz-PTT)
W89-06827

DISTRIBUTION AND MOVEMENT OF TRICHLOROETHYLENE IN GROUND WATER IN THE TUCSON AREA, ARIZONA,
Geological Survey, Tucson, AZ. Water Resources Div.
S. A. Leake, and R. T. Hanson.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4313, January 1987. 40p, 8 fig, 1 tab, 1 plate, 54 ref.

Descriptors: *Path of pollutants, *Trichloroethylene, *Groundwater pollution, *Tucson, *Arizona, Wells, Groundwater movement, Solute transport, Organic compounds, Aquifers, Fate of pollutants.

In 1981, investigations of groundwater quality around Tucson International Airport revealed a number of wells that pumped water contaminated with trichloroethylene. Subsequent investigations resulted in the delineation of three distinct areas of contamination, the largest of which encompasses about 5 sq mi of aquifer surface area. Most of the contamination is in the top 100 ft of the saturated groundwater flow system. A fine-grained confining layer that is present in much of the contaminated area significantly limits the vertical movement of the chlorinated groundwater. Within the contaminated area, measured trichloroethylene concentrations were as high as 3,100 mg/L in 1984. Measured concentrations are highly variable vertically as well as horizontally. Future quantitative studies of contaminant movement may benefit from additional data collection and experiments to determine which contaminant transport and groundwater flow equations are most appropriate. (Author's abstract)
W89-06828

NONPOINT-SOURCE AGRICULTURAL CHEMICALS IN GROUND WATER IN NEBRASKA--PRELIMINARY RESULTS FOR SIX AREAS OF THE HIGH PLAINS AQUIFER,
Geological Survey, Lincoln, NE. Water Resources Div.
H. H. Chen, and A. D. Druliner.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4338, 1987. 68p, 27 fig, 12 tab, 59 ref.

Descriptors: *Nebraska, *Nonpoint pollution sources, *Groundwater pollution, *High Plains Aquifer, *Agricultural chemicals, *Path of pollutants, Nitrates, Triazine, Herbicides, Hydraulic gradient, Hydraulic conductivity, Precipitation, Soil permeability, Nitrogen, Fertilizers, Irrigation wells.

The reconnaissance phase of a study to determine the occurrence of agricultural chemicals from nonpoint sources in groundwater in six areas, which represented the major provinces of the High Plains aquifer in Nebraska is described. In 1984, water from 82 wells in the 6 study areas was analyzed for nitrate, and water from 57 of the 82 wells was analyzed for triazine herbicides. Data for 9 of the 21 independent variables suspected of affecting concentrations of nitrate and triazine herbicides in groundwater were compiled from the 82 well sites. The variables and their ranges are: hydraulic gradient (XI), 0.006-0.0053; hydraulic conductivity (X2), 5-149 ft/day; specific discharge (X3), 0.0128-0.2998 ft/day; depth to water (X4), 3-239 ft; well depth (X5), 40-550 ft; annual precipitation (X6), 12.0-39.3 inches; soil permeability (X7), 0.76-9.0 inches; irrigation well density (X8), 0-8 irrigation wells/ sq mi; and annual nitrogen fertilizer use (X9), 0-260 lbs of nitrogen/acre. Nitrate concentrations ranged from < 0.1 to 45 mg/L as nitrogen. Triazine herbicide concentrations were detected in samples from five of the six study areas in concentrations ranging from < 0.1 to 2.3 mg/L. Statistical tests indicated that there were significant differences in nitrate concentrations among the six study areas, while no significant differences in triazine herbicide concentrations were found. Concentrations of nitrate and triazine herbicide were significantly larger in more intensively irrigated areas. Preliminary correlations with the independent variables and nitrate concentrations indicated significant relations at the 95% confidence level with variables X2, X5, and X8. Correlations with triazine herbicide concentrations indicated significant relations with variables X2, X3, X5, X6, and X8, and with nitrate concentrations (X10). By using a simple multiple regression technique, variables X5, X8, and X9 explained about 51% of the variation in nitrate concentrations. Variables X3 and X5 explained about 60% of the variation in triazine herbicide concentrations. Adding nitrate concentration as an independent variable, two variables, X10 and X3, explained 84% of the total variation in triazine herbicide concentrations. (Author's abstract)
W89-06838

GROUND-WATER FLOW NEAR TWO RADIOACTIVE-WASTE-DISPOSAL AREAS AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER, CATTARAUGUS COUNTY, NEW YORK--RESULTS OF FLOW SIMULATION,
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06841

HYDROGEOLOGY OF STRATIFIED-DRIFT AQUIFERS AND WATER QUALITY IN THE NASHUA REGIONAL PLANNING COMMISSION AREA, SOUTH-CENTRAL NEW HAMPSHIRE,
Geological Survey, Bow, NH. Water Resources

Div.
For primary bibliographic entry see Field 2F.
W89-06845

GEOHYDROLOGY AND SUSCEPTIBILITY OF MAJOR AQUIFERS TO SURFACE CONTAMINATION IN ALABAMA; AREA 8,
Geological Survey, Montgomery, AL. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06846

EFFECTS ON WATER QUALITY DUE TO FLOOD-WATER DETENTION BY BARKER AND ADDICKS RESERVOIRS, HOUSTON, TEXAS,
Geological Survey, Austin, TX. Water Resources Div.
F. Liscum, R. L. Goss, and E. M. Paul.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4356, 1987. 96p, 14 fig, 14 tab, 18 ref, 6 append.

Descriptors: *Detention reservoirs, *Storm water, *Water resources development, *Environmental effects, *Water quality, *Barker Reservoir, *Addicks Reservoir, Texas, Biological oxygen demand, Turbidity, Color, Nitrogen, Carbon, Phosphorus, Hydrogen ion concentration, Temperature, Dissolved oxygen, Coliforms, Bacteria.

The Barker and Addicks Reservoirs, located about 16 mi west of Houston, Texas, provide flood detention storage for storm runoff. Of interest are the water quality characteristics in the study area and changes in water quality during detention. Study area sampling sites were selected upstream along Buffalo Bayou for Barker Reservoir and on Bear Creek and Langham Creek for Addicks Reservoir, within the reservoirs, near the reservoir outflows, and below the confluence of each reservoir outflow at the streamflow station Buffalo Bayou near Addicks. Flow data were available at all sites except in the reservoirs. Analyses of samples collected during both low flow and storm runoff show that in general, the water of the study areas was low in mineralization, but the aesthetics of the water was a problem. The inorganic constituents, trace metals, and pesticides rarely exceeded maximum contaminant levels recommended by the EPA for public supply using 1976 and 1977 criteria for primary and secondary standards. All species of nutrients, except ammonia nitrogen and phosphorus, almost always were below the recommended maximum contaminant levels. Large values of suspended solids, turbidity, and color were common. Possible bacterial problems are indicated because coliform bacteria densities exceeded recommended levels in about 25% of the samples. The effects of the reservoirs on the water quality characteristics of storm runoff were analyzed using three approaches: (1) a comparison of the discharge weighted average values of nine selected constituents at each streamflow-gaging station during four storms (biochemical oxygen demand, suspended solids, turbidity, color, total nitrogen, total organic carbon, dissolved solids and total phosphorus); (2) an analysis of the means of the discharge weighted average values computed for the four hydrologic events using the Student t-test, indicating that reservoir detention significantly reduced suspended solids; and (3) a comparison at each site of the mean, maximum, and minimum values computed for seven constituents that did not correlate with discharge. The only consistent water quality changes observed were with the three bacteria groups, which were decreased by flood water detention. (Lantz-PTT)
W89-06847

NONPOINT-SOURCE DISCHARGES AND WATER QUALITY OF THE ELK CREEK BASIN, WEST-CENTRAL WISCONSIN,
Geological Survey, Madison, WI. Water Resources Div.
S. J. Field.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4094, March 1985. 38p, 8 fig, 24 tab, 23 ref.

Descriptors: *Nonpoint pollution sources, *Water quality, *Elk Creek, *Bruce Valley Creek, Wisconsin, Streamflow, Stream discharge, Suspended sediment, Phosphorus, Nitrogen, Ammonia.

The Elk Creek basin in west-central Wisconsin was studied during the 1980 water year to define the water quality in relation to streamflow. Agricultural nonpoint-source discharges were suspected of contributing significantly to degraded water quality. Two water quality and streamflow gaging stations were established--one on Elk Creek near Independence and the other on Bruce Valley Creek near Pleasantville. Streamflow for the 1980 water year was about 28% greater than average, and precipitation was about 36% greater than average. At Elk Creek, base flow was about 68% of the total stream discharge and, at Bruce Valley Creek, base flow was about 56% of the total stream discharge. Streamflow at Elk Creek during the study ranged from 43 to 1,020 cu ft/sec; Bruce Valley Creek discharges ranged from 2.8 to 306 cu ft/sec. The low flow discharges are significantly greater than the 2-year, 7-day low flow, whereas the peak discharges were between a 2-year and a 5-year flood recurrence interval. Suspended-sediment yields were greatest at Bruce Valley Creek, and was 215 ton/sq mi/yr compared with 184 ton/sq mi/yr for Elk Creek. Double mass-accumulation curves, however, indicated that loading rates were similar for both stations. Suspended sediment and nutrient yields were slightly above the long-term average. Total phosphorus , ammonia nitrogen, and organic nitrogen yields also were highest at Bruce Valley Creek. Phosphorus yields at Bruce Valley Creek were 1,6000 lb/sq mi/yr compared with 1,350 lb/sq mi/yr at Elk Creek. Because base flow was a greater percentage of total discharge, nitrite plus nitrate nitrogen yields and loads were highest at Elk Creek. All phosphorus concentrations at Bruce Valley and Elk Creeks exceeded levels recommended by EPA to prevent the formation of biological nuisance growths. Only one sample, collected on March 18, 1980, at Bruce Valley Creek may have exceeded the Wisconsin Department of Natural Resources criterion of toxic levels for un-ionized ammonia (0.04 mg/L). No samples from Elk Creek extended the criteria. (Author's abstract)
W89-06853

GROUND-WATER QUALITY IN WYOMING,
Geological Survey, Cheyenne, WY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06855

QUALITY OF GROUND WATER IN THE PUGET SOUND REGION, WASHINGTON, 1981,
Geological Survey, Tacoma, WA. Water Resources Div.
G. L. Turney.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4258, 1986. 170p, 2 fig, 4 tab, 2 plates, 24 ref.

Descriptors: *Groundwater, *Water quality, *Water resources data, *Water analysis, *Washington, Hydrogen ion concentration, Specific conductivity, Iron, Manganese, Nitrates, Bacteria, Coliforms, Aluminum, Selenium, Arsenic, Barium, Cadmium, Chromium, Copper, Lead, Mercury, Silver, Zinc, Heavy metals, Drinking water, Water quality, Chemical analysis, Puget Sound.

Groundwater from more than 100 sites in the Puget Sound region, Washington, was sampled and analyzed in 1981 for pH, specific conductance, and concentrations of fecal coliform bacteria, major ions, and dissolved iron, manganese, and nitrate. 20% of the samples were analyzed for concentrations of dissolved trace metals including aluminum, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, silver, and zinc. The predominant water types were calcium bicarbonate and calcium-magnesium bicarbonate. Some wells in San Juan and Island Counties contained sodium chloride as a result of seawater intrusion. Dissolved solids concentrations were generally < 150 mg/L. Iron concentrations > 300 micrograms/L in 14% of all samples. Manganese concentrations > 50 micrograms/L in 40% of all samples. Trace-metal concentrations were generally < 10 mg/L, except for barium, copper, lead, and zinc. Nitrate concentrations were < 1.0 mg/L in water for over 75% of the sites. Concentrations > 1.0 mg/L in samples from Skagit, Whatcom, and Pierce Counties, were probably due to agricultural activities or septic tanks. Fecal coliform bacteria were detected in isolated instances. EPA drinking water regulations were exceeded only in isolated instances, except for widespread excessive iron and manganese concentrations. The historical data for the region were also evaluated for the same constituents. There are quantitative differences between historical and 1981 data, but they may be due to inconsistencies in data collection and analytical methods. (Author's abstract)
W89-06866

EFFECTS OF COAL MINE DRAINAGE ON THE WATER QUALITY OF SMALL RECEIVING STREAMS IN WASHINGTON, 1975-77,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 4C.
W89-06882

TRACE-METAL LEACHING FROM PLUMBING MATERIALS EXPOSED TO ACIDIC GROUNDWATER IN THREE AREAS OF THE COASTAL PLAIN OF NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
G. R. Kish, J. A. Macy, and R. T. Mueller.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 87-4146, 1987. 19p, 2 fig, 6 tab.

Descriptors: *Lead, *Drinking water, *Water quality, *Trace metals, *Copper, *New Jersey, Atlantic Coastal Plain, Groundwater, Tap water, Drinking water, Domestic wells, Alkalinity, Atlantic County, Ocean County, Hydrogen ion concentration.

The U.S. Geological Survey analyzed trace metal concentrations in tap water from domestic wells in newly constructed homes in Berkeley Township, Ocean County and Galloway Township, Atlantic County, N. J. The potable water distribution systems in all of the homes sampled are constructed primarily of copper with lead-based solder points. Home water treatment is used in Berkeley Township but not in Galloway Township. Tap water was collected after the water had been standing in the pipes overnight. In Berkeley, 6 to 11 samples exceeded both the U.S. Environmental Protection Agency's primary drinking water regulation (DWR) for lead (50 microgram/L) and the secondary drinking water regulation (SDWR) for copper (1,000 microgram/L). In Galloway, 12 of 14 samples exceeded the DWR for lead and 13 of 14 exceeded the SDWR for copper. After collecting the standing-water samples, the water was left running for 15 minutes and a second sample was collected. None of the running-water samples exceeded the regulations for lead or copper. Available data suggest a correlation between the residence time of soft, acidic groundwater in new home plumbing systems and elevated trace-metal concentrations in drinking water derived from domestic wells within the New Jersey Coastal Plain. (USGS)
W89-06884

PRELIMINARY ASSESSMENT OF WATER QUALITY AND ITS RELATION TO HYDROGEOLOGY AND LAND USE: POTOMAC-RARITAN-MAGOTHY AQUIFER SYSTEM, NEW JERSEY,
Geological Survey, Trenton, NJ. Water Resources Div.
C. Barton, E. F. Vowinkel, and J. P. Nawyn.
Available from Books and Open File Report Sec-

tion, USGS, Box 25425, Denver, CO 80225; paper copy $13.00, microfiche $4.00. USGS Water Resources Investigation Report 87-4023, 1987. 79p, 23 fig, 16 tab, 69 ref.

Descriptors: *Groundwater, *Water quality, *Geohydrology, *Water pollution sources, *Land use, *New Jersey, Organic compounds, Trace metals, Nutrients, Network design, Areal hydrogeology, Water sampling, Potomac-Raritan-Magothy aquifer.

The relation of water quality to hydrogeology and land use was evaluated using analysis of water samples from 71 wells in the northern part of the Potomac-Raritan-Magothy aquifer system in New Jersey. The sampling network was evaluated for variations in hydrogeology. Well depths, pumping rates, and the number of wells in the confined and unconfined parts of the aquifer system did not differ among land-use groups. The influences of hydrogeologic factors on water quality were evaluated without considering land use. Shallow wells had the highest specific conductance and major ion concentrations. Water from wells in the unconfined part of the aquifer system had the highest dissolved organic carbon concentration. Dissolved oxygen and nitrate concentrations were lowest, trace metals concentrations were highest, and phenols were detected most frequently in groundwater from undeveloped land. Major ions and trace metals concentrations were lowest, dissolved oxygen and copper concentrations were highest, and pesticides were most frequently detected in groundwater from agricultural land. Nitrate concentrations were highest and orthophosphate, nitrite, and purgeable organics were detected most frequently in groundwater from urban land. These water quality data were compared to data from the same aquifer system in southern New Jersey. Frequencies of detection of purgeable organics among land-use groups were similar in the northern and southern areas. (USGS)
W89-06888

OPTIMAL SCHEMES FOR GROUNDWATER QUALITY MONITORING IN THE SHALLOW AQUIFER, DOUGHERTY PLAIN, SOUTHWESTERN GEORGIA,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
S. Rouhani, and T. J. Hall.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 202577/AS, price codes: A04 in paper copy; A01 in microfiche. Georgia Environmental Resources Center, Atlanta, Report ERC 03-87, March 1987. 49p, 26 fig, 4 tab, 14 ref. USGS contract 14-08-0001-G1219. USGS project G1219-05.

Descriptors: *Network design, *Statistical methods, *Regional analysis, *Water quality, *Water management(Applied), *Georgia, Dougherty Plain.

Geostatistical schemes for groundwater quality monitoring in the shallow aquifer of Dougherty Plain, Georgia are presented. This aquifer is not generally used for water supply purposes. However, it is the main recharge route to the principal artesian aquifer which is the primary source of water supply in this rapidly growing agricultural region. The desired monitoring network acts as an early warning system for groundwater pollution in deeper layers. Available data on hydraulic properties of the shallow aquifer was used to identify the zones which should be the primary locations for sampling activities. The one variable which appears to be most suitable for study is leakance. Statistical analyses indicate that leakance has a log-normal distribution with a constant trend and a linear covariance function. Ranking criteria for the selection of the best sampling points are: the variance reductions, the medians, and the risk values. Due to the nature of monitoring network risk ranking will be mainly used as the basis of the sampling activities. The results of the risk rankings demonstrate that the southern tip of the Dougherty Plain and its upper central zone should be the prime targets of the monitoring activities. (Rouhani-GA Inst. Tech.)
W89-06896

INTERACTIVE ENVIRONMENTAL IMPACT AND ECONOMIC ANALYSIS OF THE BENEFITS OF POTABLE GROUNDWATER ON CAPE COD,
Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 5G.
W89-06911

SIMPLE STOCHASTIC MODEL PREDICTING CONSERVATIVE MASS-TRANSPORT THROUGH THE UNSATURATED ZONE INTO GROUNDWATER,
Wisconsin Univ., Madison. Dept. of Civil and Environmental Engineering.
J. S. Brasino.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8618261. Ph. D. Dissertation, 1986. 254p, 77 fig, 1 tab, 87 ref, 13 append.

Descriptors: *Mathematical models, *Path of pollutants, *Infiltration, *Mass transfer, *Groundwater pollution, *Model studies, Agricultural chemicals, Agricultural runoff, Bromides, Tracers, Flow characteristics.

Random variables were introduced into a physically-based mathematical model of transport to predict the early arrival of a tracer at the water table far in advance of the center of mass of a source pulse of a conservative, non-adsorbing tracer. The model was calibrated using field experiments. A randomized plug flow (RPF) model was developed and Jury's transfer function model (TFM) was defined in the context of the RPF model. Normal distributions and those adjusted using the TFM show the best agreement with the percent of mass transported to the groundwater as determined using well samples. Calibration of the model using the ergodic hypothesis in time and assuming a normal distribution provided an adequate fit to field data. This procedure avoids the use of net infiltration, which is difficult to obtain, and minimized the effects of sample intervals. A normal model allows finite probability for negative values. Thus, a log normal model is recommended to simulate transport with high variability or transport to shallow water tables. The RPF model will probably provide good estimates of mass transport to groundwater in sandy soils. (Cremmins-AEPCO)
W89-06918

TIME SERIES AND TRANSECT ANALYSIS OF WATER QUALITY IN SAYLORVILLE AND RED ROCK RESERVOIRS,
Iowa State Univ., Ames. Dept. of Civil Engineering.
V. O. Okereke.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627142. Ph.D. Dissertation, 1986. 229p, 38 fig, 133 tab, 101 ref, append.

Descriptors: *Time series analysis, *Water quality, *Reservoirs, Fourier analysis, Ammonia, Nitrogen, Orthophosphates, Nitrates, Suspended solids, Phosphates, Biochemical oxygen demand, Nitrates.

Transect studies and time series analysis of water quality were conducted for the Saylorville and Red Rock Reservoirs in Iowa. Three-way analysis of variance of the transect data showed that the Saylorville Reservoir was thermally and chemically stratified during a first study and mixed during a second one. The Red Rock Reservoir was mixed during the first two of ten studies, but was fully or partially stratified during the other eight. Depth gradients of dissolved oxygen concentrations were always greater than the gradients of any other parameter. Transverse and longitudinal gradients were not statistically significant in nearly all cases analyzed and short-circuiting may not be a significant problems at either of the reservoirs. Time series analysis results showed that the trends in ammonia and orthophosphate concentrations were generally very low. Ammonia concentrations rarely exceeded the State of Iowa standards. Despite more frequent incidences of extremely high concentrations of suspended solids and total phosphate the average concentrations of these parameters have not been increasing. Results indicated that nitrogenous fertilizer use has doubled in the region during the study period. But this use did not result in a corresponding increase in the concentrations of nitrite plus nitrate nitrogen. Instead, the trend in their concentrations increased or decreased as a factor of runoff. (Cremmins-AEPCO)
W89-06920

MIGRATION OF RADIOACTIVE WASTES FROM SHALLOW LAND BURIAL SITE UNDER SATURATED AND UNSATURATED CONDITIONS,
Georgia Inst. of Tech., Atlanta. Div. of Graduate Studies in Health Physics.
J. Whang.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8628369. Ph.D. Dissertation, 1986. 229p, 55 fig, 12 tab, 162 ref, 2 append.

Descriptors: *Path of pollutants, *Groundwater pollution, *Radioactive wastes, *Radioactive waste disposal, *Land disposal, *Unsaturated flow, *Saturated flow, Flow characteristics, Model studies, Computer programs, Finite element method, Migration.

The effect of hydrologic flow conditions on the migration of radionuclides and the ability of a model to predict the redistribution of radionuclides were studied. Soil near the waste disposal site at the Savannah River Plant was used in the flow and transport experiments. A method for yielding a constant unsaturated flow was adequate within the range of applied negative pressure and confirmed that the infiltration of water into a dry soil followed the wetting curve on the soil-water characteristics. Results of transport experiment showed that a relation exists between the distribution coefficient and hydrologic flow effects. A two-dimensional finite element model predicted the redistribution of low-level waste buried on site under various degrees of saturation. The conservative assumption in most models that the soil is always saturated may lead to significant overestimation of radionuclide migration. Long-term prediction of radionuclide migration in a natural field requires the testing of mass balance and model modifications to accommodate the hysteresis effect and the effect of layered soil, at the expense of added computational time. (Cremmins-AEPCO)
W89-06923

STUDY OF THERMALLY INDUCED TIME-DEPENDENT CANISTER MIGRATION,
California Univ., Berkeley. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-06926

GROUNDWATER CONTAMINATION ASSESSMENTS,
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 7A.
W89-06927

CHLORINATED ORGANICS REMOVAL FROM CONTAMINATED SOIL AND GROUNDWATER BY MICROORGANISMS,
Minnesota Univ., Minneapolis. Graduate School.
For primary bibliographic entry see Field 5G.
W89-06928

GEOCHEMISTRY OF COPPER AND CHROMIUM ORGANIC COMPLEXES IN NARRAGANSETT BAY INTERSTITIAL WATERS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
For primary bibliographic entry see Field 2L.
W89-06931

AIR EMISSIONS OF VOLATILE ORGANICS FROM A SIMULATED HAZARDOUS LIQUID WASTE LAGOON,
Illinois Univ. at Chicago Circle. School of Public

Health.
L. R. Berrafato.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8605072. Ph.D. Dissertation, 1985. 234p, 27 fig, 58 tab, 54 ref, 7 append.

Descriptors: *Wastewater lagoons, *Air pollution, *Wastewater treatment, *Hazardous materials, *Liquid wastes, Volatility, Mass transfer, Model studies, Simulation analysis.

Meteorological data, waste lagoon pool condition, and liquid and air sampling data were analyzed to compare predicted emission rates, mass transfer coefficients, and air concentrations with theoretical models and a box-model for dispersion of the chemicals into the atmosphere above the pool. Chlorobenzene and toluene were put into a dilute aqueous solution in a simulated hazardous liquid waste lagoon. For both toluene and chlorobenzene, approximately 90% of the added material was lost either to liquid globules or to air in the first half hour and the overall mass transfer coefficient gas phase (K1) and emission rate (E) were better predicted in the greater than 7 hour range. For toluene, the models were generally appropriate and the predicted mean value of K1 ranged by a factor of 10 (molecular weight ratio model, MWR) to 1/10 (oxygen reaeration ratio model, ORR) of the observed mean value for longer time intervals. For chlorobenzene, the correlation was not good, but the magnitude was in agreement with the observed values. The mean predicted value of K1 ranged by a factor of 15 (MWR) to 1/7 (ORR) of the observed mean value for longer time intervals. Solar radiation was important in terms of chemical release. Windspeed affected the air concentrations but was not important in terms of chemical release. (Cremmins-AEPCO)
W89-06944

GROUNDWATER CONTAMINATION BY THE HERBICIDE ATRAZINE, WELD COUNTY, COLORADO,
Colorado State Univ., Fort Collins. Dept. of Microbiology and Environmental Health.
M. P. Wilson.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8705493. Ph.D. Dissertation, 1985. 185p, 29 fig, 32 tab, 239 ref, 2 append.

Descriptors: *Path of pollutants, *Fate of pollutants, *Herbicides, *Groundwater pollution, *Groundwater movement, Water pollution control, Model studies, Wastewater disposal, Adsorption, Degradation, Mass transfer, Mathematical models, Colorado, South Platte River Valley.

A field study was conducted and a groundwater transport model was developed to investigate potential contamination of groundwater underlying and downgradient from an atrazine treated site in the South Platte River Valley, Colorado. Groundwater from wells was monitored and whether atrazine is or is not a conserved species in the groundwater and the likelihood of N-nitrosatrazine formation from leached atrazine were assessed. The transport model was used to determine the transport rate, dilution, and attenuation of atrazine in groundwater. Atrazine residues were identified in samples from beneath and downgradient atrazine-treated fields in concentrations to 2.3 ppb. A significant decline in the downgradient groundwater concentrations of atrazine was observed. The highest concentration measured was less than one-third the suggested adverse-effect level proposed for atrazine by the National Academy of Science when one percent of the allowable daily intake is obtained from drinking water. Conditions at the site indicated the unlikelihood of N-nitrosatrazine formation. The steady state model of atrazine transport through the aquifer underlying the site revealed a marked influence by adsorption and degradation. Assumed values of atrazine adsorption to aquifer solids yielded a significant delay in atrazine mass breakthrough. (Cremmins-AEPCO)
W89-06950

SOLUBILITY, MOBILITY AND PLANT UPTAKE OF TOXIC ELEMENTS IN RETORTED OIL SHALES AS AFFECTED BY RECARBONATION,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
K. J. Reddy.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8705479. Ph.D. Dissertation, 1986. 106p, 14 fig, 16 tab, 54 ref, append.

Descriptors: *Solubility, *Oil shale, *Mine reclamation, *Groundwater pollution, *Water pollution control, Leaching, Carbonates, Calcium, Magnesium, Alkalinity, Solid wastes, Toxicity, Revegetation.

The solid phases controlling calcium and magnesium activities and the high alkalinity of retorted shales were determined. The recarbonation of the shales was monitored and the mineral transformations that occur as C02(g) is supplied to them were examined. A method for the recarbonation of the shales was developed. The solubility of trace elements in retorted shales was determined before and after recarbonation and the effect of recarbonation on the leachability and plant uptake of trace elements was examined. Chemical equilibrium principles can be used to explain solubility relationships and mineral transformations of retorted shales. The high pH near 11.5 of many retorted shales results when solubility control shifts from calcite to Ca and Mg silicates, because of loss of CO2(g). Recarbonation, however, returned this control back to carbonates and atmospheric CO2(g) as pH again dropped to 8.5. The findings are useful in developing reclamation programs for revegetating retorted shales, for minimizing the leaching of toxic elements into groundwater, and for preventing the movement of toxic elements into the food chain. (Cremmins-AEPCO)
W89-06953

BIODEGRADATION OF ORGANIC CONTAMINANTS IN THE SUBSURFACE OF HAZARDOUS WASTE SITES,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
For primary bibliographic entry see Field 5E.
W89-06957

SEDIMENT AND PHOSPHORUS LOAD TO STREAMFLOW FROM NATURAL AND DISTURBED WATERSHEDS IN NORTHEASTERN MINNESOTA,
Minnesota Univ., Minneapolis. Graduate School.
For primary bibliographic entry see Field 4C.
W89-06965

SULFATE CONTAMINATION IN GROUNDWATER NEAR AN ABANDONED MINE: HYDROGEOCHEMICAL MODELING, MICROBIOLOGY AND ISOPTOPE GEOCHEMISTRY,
Wisconsin Univ.-Madison.
L. E. Toran.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8623704. Ph.D. Dissertation, 1986. 213p, 46 fig, 17 tab, 146 ref, append.

Descriptors: *Model studies, *Acid mine drainage, *Groundwater pollution, *Sulfates, *Groundwater movement, *Water pollution control, *Mine wastes, Computer models, Microbiological studies, Geochemistry, Isotope studies, Wisconsin.

Sulfate contamination in a carbonate aquifer near abandoned zinc and lead mines in Wisconsin was studied using geochemical computer modeling, isotope interpretation, microbiological sampling, laboratory experiments, and groundwater flow modeling. A three-dimensional groundwater flow model suggests that groundwater will begin to flow away from the mines between 1989 and 1994. However, because of dilution, sulfate levels should remain low in areas distant from the mines. Modeling using the USGS program PHREEQE showed the importance of dolomite, calcite, C02, and iron hydroxides in controlling the water chemistry. Carbon isotope modeling results were consistent with dilution of contaminated water. Microbiological sampling and sulfur isotopes indicated that Thiobacillus bacteria that thrive under neutral pH conditions may be involved in the oxidation process. Acidophillic bacteria were also found. In sterile experiments there was negligible sulfur isotope fractionation between solid sulfides and dissolved sulfate. Experiments inoculated with Thiobacilli showed sulfate 0 to 5% lighter than sulfide. Oxygen isotope ratios from both inoculated and sterile experiments indicated a large portion of sulfate oxygen comes from water rather than from atmospheric oxygen. (Cremmins-AEPCO)
W89-06972

5C. Effects Of Pollution

DIRECT VIABLE COUNTING METHOD FOR MEASURING TOLERANCE OF AQUATIC MICROBIAL COMMUNITIES TO HG(2+),
Technology Applications, Inc., Gulf Breeze, FL.
For primary bibliographic entry see Field 7B.
W89-05814

CHEMICAL QUALITY OF MATERNAL DRINKING WATER AND CONGENITAL HEART DISEASE,
Brown Univ., Providence, RI. Div. of Biological and Medical Sciences.
S. Zierler, M. Theodore, A. Cohen, and K. J. Rothman.
International Journal of Epidemiology IJEPBF, Vol. 17, No. 3, p 589-594, September 1988. 5 tab, 16 ref.

Descriptors: *Water quality, *Potable water, *Human pathology, *Water pollution effects, Water pollution, Toxicity, Congenital heart disease, Chemical exposure, Selenium, Lead, Mercury, Arsenic, Statistical analysis, Population exposure, Water quality standards, Public health.

A case-control study was undertaken to investigate the association between chemicals in maternal drinking water consumed during pregnancy and congenital heart disease in the offspring. Two hundred seventy affected children and 665 healthy children were enrolled in the study. Information on contaminant levels in maternal drinking water was available from records of routine water analysis of samples taken from public taps in the communities where the mothers resided during pregnancy. Mothers provided information during a telephone interview on their health, pregnancy management, and demographic characteristics. Nine inorganic metals were analyzed for detection of an association with congenital heart disease. The chemical exposures of particular interest were arsenic, lead, mercury and selenium. None of the chemicals was associated materially with an increase in the frequency on congenital heart disease overall. Arsenic exposure at any detectable level was associated with a 3-fold increase in occurrence of coarctation of the aorta (prevalence odds ratio = 3.4, 95% confidence interval = 1.3-8.9). Detectable traces of selenium in drinking water were associated with a lower frequency of any congenital heart disease than was observed among children exposed to drinking water not containing detectable levels of selenium (prevalence odds ratio = 0.62, 95% confidence limits = 0.40-0.97). A dose-response effect was observed over 4 levels of selenium exposure. Non-differential errors in the measurement and classification of exposure to contaminants routinely monitored in drinking water could account for lack of positive findings. In addition, most of the contaminant levels were below the maximum levels set by the Environmental Protection Agency, so that lack of evidence of effect may have been due to the low exposure levels in this population. (Author's abstract)
W89-05869

WATER SUPPLY, SANITATION AND HOUSING IN RELATION TO THE RISK OF INFANT MORTALITY FROM DIARRHEA,
Universidade Federal de Pelotas (Brazil). Dept. de Medicina Social.
C. G. Victora, P. G. Smith, J. E. Vaughan, L. C. Nobre, and C. Lombardi.

International Journal of Epidemiology IJEPBF, Vol. 17, No. 3, p 651-654, September 1988. 2 tab, 13 ref.

Descriptors: *Domestic water, *Epidemiology, *Human pathology, *Water pollution effects, *Mortality, *Sanitation, Water quality, Children, Diarrhea, Risks.

In a population-based case-control study in the metropolitan areas of Porto Alegre and Pelotas in southern Brazil, children dying in infancy from diarrhea were compared to neighborhood controls in terms of several social and environmental variables. Factors found to be significantly associated with an increased risk of death from diarrhea included the non-availability of piped water, the absence of a flush toilet, residence in a poorly built house and household overcrowding. When adjustment was made for confounding variables and the mutual confounding effect of the environmental variables on each other, the only association that remained statistically significant was that with the availability of piped water. The association with poor housing was almost significant (rho=0.052). Compared to those with water piped to their house, those without easy access to piped water were found to be 4.8 times more likely to suffer infant death from diarrhea (95% confidence interval 1.7 to 13.8) and those with water piped to their plot but not to their house had a 1.5 times greater risk (95% confidence interval 0.8 to 3.0). (Author's abstract)
W89-05870

ESTUARY REHABILITATION: THE GREEN BAY STORY,
Wisconsin Univ.-Madison. Sea Grant Inst.
For primary bibliographic entry see Field 4C.
W89-05909

PLASMIDS IN THE BACTERIAL ASSEMBLAGE OF A DYSTROPHIC LAKE: EVIDENCE FOR PLASMID-ENCODED NICKEL RESISTANCE,
Max-Planck-Inst. fuer Limnologie zu Ploen (Germany, F.R.).
C. Schutt.
Microbial Ecology MCBEBU, Vol. 17, No. 1, p 49-62, January/February 1989. 3 fig, 3 tab, 35 ref.

Descriptors: *Lakes, *Dystrophic lakes, *Aerobic bacteria, *Nickel, *Resistance, *Water pollution, *Water pollution effects, Plasmids, Humic compounds, Heavy metals, Aromatic compounds, Sweden, Biotransformation.

Sixty-two aerobic bacterial strains isolated from the unproductive dystrophic Lake Skarshultsjon (South Sweden) were screened for plasmids. One third of the isolates harbored multiple plasmids usually of similar high molecular weights (> 25 Mdal). The plasmid-bearing strains were members of the common aquatic taxa Pseudomonas spp., Acinetobacter sp., Alcaligenes sp., Aeromonas/Vibrio group, and Enterobacteriaceae (taxonomy is tentative). The majority of isolates displayed multiple resistance to antibiotics and heavy metals. Some of them were capable of degrading aromatic compounds. Three isolates were chosen for curing experiments. Only strain S-68, an Alcaligenes sp., could be cured of one of its two plasmids. It harbored the two cryptic plasmids pQQ32 and pQQ70 of 32 and ca. 70 Mdal, and the latter was segregated during ethidium bromide treatment. Parental strain S-68 was capable of degrading some of the nonchlorinated phenolic compounds and displayed resistance to a broad spectrum of antibiotics and the heavy metals Co(+2), Ni(+2), Zn(+2), Cd(+2), and Hg(+2). Derivative strain S-68-41 lost its resistance to nickel, suggesting segregated plasmid pQQ70 coded for nickel resistance. Transformation experiments to restore nickel resistance in the cured derivative strain were not successful. (Author's abstract)
W89-05967

EFFECTS OF SIMULATED ACID RAIN ON SOIL AND LEACHATE ACIDIFICATION OF A LEXINGTON SILT LOAM,
California Univ., Berkeley. Dept. of Plant and Soil Biology.
B. C. Liljeholm, and S. E. Feagley.
Soil Science SOSCAK, Vol. 146, No. 1, p 44-50, July 1988. 6 fig, 4 tab, 20 ref.

Descriptors: *Acidic soils, *Soil contamination, *Acid rain, *Simulated rainfall, *Leachates, *Water pollution effects, Fate of pollutants, Silt, Acidification, Loam, Rainfall impact, Water pollution, Hydrogen concentration, Conductivity, Aluminum.

A laboratory investigation, to provide information on possible effects on soil and soil leachate resulting from large volumes of acid input, is described. Soil cores with a diameter of 5 cm to a depth of 15.2 cm were collected from a Lexington silt loam. Simulated precipitation with adjusted pH values of 3.7, 4.7, and 5.7 was applied to the soil cores in increments of 5000 ml per d until total applications approximating 10, 20, 40 and 80 yr of effective rainfall in Louisiana were reached. The exchangeable acidity, exchangeable Al, and KCl pH were measured from 2.5 cm sections of the soil cores after treatment. The leaching solution of pH 3.7 after 80 yr volume of application had the greatest effect on soil pH, exchangeable acidity, and exchangeable Al. Leachate pH, electrical conductivity, and cumulative Al were measured after each 5 yr of volume of application. The leachate pH values caused by the 3.7 and 4.7 pH leaching solutions were higher than the initial leaching solution pH values. The leaching solution of pH 3.7, however, caused the lowest leachate pH and highest electrical conductivity and cumulative Al. The volume of application caused no major trends in the data. (Author's abstract)
W89-06012

VOLATILE COMPOUNDS IN FLAVOR-TAINTED FISH FROM THE UPPER WISCONSIN RIVER,
Wisconsin Univ.-Madison. Environmental Toxicology Center.
T. P. Heil, and R. C. Lindsay.
Journal of Environmental Science and Health (B) JPFCD2, Vol. 23, No. 5, p 489-512, October 1988. 1 fig, 1 tab, 56 ref.

Descriptors: *Volatile organic compounds, *Taste, *Fish, *Wisconsin River, *Pulp wastes, *Water pollution effects, Organoleptic properties, Municipal wastes, Tissue analysis.

Results of systematic studies are presented on the volatile compounds present in non-tainted fish and flavor-tainted fish from a section of the upper Wisconsin River that is influenced by several pulp and paper mills, municipalities and other industry. Attention has been focused on compounds with aroma qualities indicative of a potential for flavor-tainting of fish. Fillets from Walleye pike and Northern pike captured from the river were analyzed for volatile aromatic components using simultaneous steam distillation-extraction and gas chromatography/mass spectrometry techniques. Based on comparative odor assessments of eluting gas chromatography fractions and gas chromatography/mass spectrometry analysis between control and tainted fish, trace amounts of alkylphenols and thiophenol were identified as the principal contributors to flavor tainting found in fish during the spring of the year. Geosmin and 2-methylisoborneol were major contributors to mustiness flavor-tainting occurring in fish captured in the late summer and were more abundant in downstream fish than in upstream control fish. (Miller-PTT)
W89-06013

MULTIPLE TOXICITY AND ACCUMULATION OF HEAVY METALS IN TWO BIVALVE MOLLUSC SPECIES,
Tvarminne Zoological Station (Finland).
S. Kaitala.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 23-32, 1988. 3 fig, 7 tab, 35 ref.

Descriptors: *Water pollution effects, *Bioaccumulation, *Heavy metals, *Mollusks, *Toxicity, Clams, Mytilus, Metabolism, Path of pollutants, Copper, Zinc, Manganese.

Single and combined additions of copper (0.2 mg/L), zinc (0.4 mg/L) and manganese (2 mg/L) were used to examine the multiple accumulation and toxicity of these metals in sessile blue mussel Mytilus edulis and burrowing clam Macoma baltica in a 2(cubed)-factorial experiment. Concentrations of metals were analyzed with atom absorption spectrometry. The accumulation of metals and their toxicity were determined by regression analyses. The presence of copper ions stimulated the accumulation of zinc and manganese in mussels so that the concentration of manganese was 100% and zinc 25% higher than without copper additions. In accumulation of manganese and copper in clams, other metals did not have any effect and zinc did not accumulate at all. The values of lethality (LC sub 50) were 127 micrograms Cu/L for mussels in 8 days and 54 micrograms Cu/L for clams in 10 days. (Author's abstract)
W89-06016

DOSE-RELATED TOXICITY OF COPPER AND CADMIUM IN STRIPED BASS LARVAE FROM THE CHESAPEAKE BAY: FIELD CONSIDERATIONS,
Maryland Univ., Solomons. Center for Environmental and Estuarine Studies.
D. A. Wright.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 39-48, 1988. 9 fig, 24 ref.

Descriptors: *Toxicity, *Cadmium, *Copper, *Bass, *Larvae, *Chesapeake Bay, Bioaccumulation, Estuaries, Lethal limit, Heavy metals, Pollution load, Sediments.

Copper and cadmium monitoring in Chesapeake Bay sediments indicates that metal contamination exists in nursery areas for striped bass (Morone saxatilis), which has been in serious decline over the last 17 years. Whole water metal concentrations in one spawning river were within an order of magnitude of published acutely toxic concentrations. Larval striped bass were exposed in the laboratory to copper and cadmium concentrations which were acutely toxic over a 96 h period (24 and 19 micrograms/L, respectively), and to sublethal concentrations of these metals over a three week period. Larvae from acutely toxic metal treatments, sub-lethal metal concentrations and control tanks were analyzed for cadmium and copper and the frequency distribution of metal body burdens was compared with field data. The distribution of copper concentrations in laboratory-exposed larvae was completely within the range of field specimens, and there was considerable overlap in cadmium frequency distributions from laboratory and field larvae. These results together with other published data suggest that environmental metal concentrations in some spawning tributaries of the Chesapeake Bay may pose a threat to striped bass, and the suggestion is made that greater efforts should be made to link laboratory and field toxicological data. (Author's abstract)
W89-06018

EFFECTS OF SEWAGE SLUDGE DISPOSAL TO SEA - THE OUTER THAMES ESTUARY, U.K.,
Water Research Centre, Medmenham (England).
K. Whitelaw, and M. J. Andrews.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 183-191, 1988. 7 fig, 3 tab, 14 ref.

Descriptors: *England, *Ocean dumping, *Sludge disposal, *Thames estuary, *Water pollution effects, *Estuarine environment, Environmental effects, Path of pollutants, Sediment transport, Radioactive tracers, Coliforms, Fish diseases, Sublethal effects.

Sewage sludge disposal in the Outer Thawes estuary is the largest operation of its kind in the United Kingdom. This paper reports interim results from a four-year study of the effects of this sludge upon the environment of the outer estuary. Using radiolabeled sludge and fecal bacteria, the sludge was shown to disperse widely soon after disposal. Dispersion in the sediments is being followed over a

period of one year. Mussels placed in cages along the known dispersion path of sludge in the water column exhibited sub-lethal physiological stress. However, the benthic infauna distributions were shown to be related principally to sediment characteristics and no effect due to sludge could be detected. The incidence of epidermal diseases in fish was low and that from the vicinity of the disposal ground was similar to that from a nearby commercially-fished area to which the sludge did not disperse. (Author's abstract)
W89-06033

SUSCEPTIBILITY OF U.S. ESTUARIES TO POLLUTION,
Delaware Univ., Newark. Coll. of Marine Studies.
For primary bibliographic entry see Field 5B.
W89-06036

INTRODUCTION: AQUATIC ORGANISMS AS INDICATORS OF ENVIRONMENTAL POLLUTION,
National Marine Fisheries Service, Miami, FL. Southeast Fisheries Center.
For primary bibliographic entry see Field 5A.
W89-06046

BIOLOGICAL INDICATORS AND BIOLOGICAL EFFECTS OF ESTUARINE/COASTAL POLLUTION,
National Marine Fisheries Service, Oxford, MD. Northeast Fisheries Center.
For primary bibliographic entry see Field 5A.
W89-06047

SMALL FISH MODELS FOR IDENTIFYING CARCINOGENS IN THE AQUEOUS ENVIRONMENT,
Gulf Coast Research Lab., Ocean Springs, MS.
For primary bibliographic entry see Field 5A.
W89-06048

CAGED FISH AS MONITORS OF POLLUTION: EFFECTS OF CHLORINATED EFFLUENT FROM A WASTE WATER TREATMENT PLANT,
Auburn Univ., AL. Dept. of Fisheries and Allied Aquacultures.
For primary bibliographic entry see Field 5A.
W89-06049

ABNORMALITIES AND DISEASES OBSERVED IN COMMERCIAL FISH CATCHES FROM BISCAYNE BAY, FLORIDA,
R. H. Skinner, and W. Kandrashoff.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 961-966, October 1988. 1 fig, 4 tab, 20 ref.

Descriptors: *Fish, *Florida, *Fish diseases, *Animal pathology, *Water pollution effects, *Biscayne Bay, Urban regions, Fish harvest, Marine fisheries, Fisheries, Marine environment.

Many of the most productive fishing grounds in the United States are estuaries and bays which are located near population and industrial centers, and therefore subjected to pollution. Observations made on 17 fish species from commercial catches harvested in north Biscayne Bay, Florida, an urban area, showed high numbers of individuals suffering from abnormalities and diseases. Seven groups of disorders most frequently affected bottom feeders. Fin and integumental hemorrhages occurred in all individuals in 26 of 43 catches of Mugil cephalus (striped mullet), and in all individuals in 24 of 30 catches of Micropogon undulatus (Atlantic croaker). Disorders occurring consistently in a location exposed to pollutants but uncommon in other areas of the species' range point to environmental stress as a probable cause. (Author's abstract)
W89-06050

DETERMINING THE RELATIONSHIP BETWEEN WATER QUALITY AND INFECTIOUS DISEASE IN FISHERY POPULATIONS,
North Carolina State Univ. at Raleigh. Coll. of Veterinary Medicine.
E. J. Noga.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 967-973, October 1988. 4 fig, 1 tab, 21 ref. Univ. of North Carolina Water Resources Research Institute Grant 70054 and NOAA Office of Sea Grant NA 83AA-D-0012.

Descriptors: *Fish diseases, *Fish populations, *Water pollution effects, *Pathogenic fungi, *Fungi, *Epidemiology, Infection, Estuarine environment, Epidermis.

Diseases in wild fish populations may have multiple economic and social impacts. Epidemics of infectious diseases, which are associated with the presence of some microbe or parasite, have recently been observed in several major estuarine systems in the eastern United States. The most prevalent of these problems is ulcerative mycosis (UM), a fungal infection. The agents responsible for UM and many of these other diseases are opportunistic pathogens that are not believed to infect normal, immunocompetent individuals. While inroads have been made into determining the infectious agents associated with these diseases, very little is known of how pollution may influence their prevalence. Understanding the importance of pollution requires an awareness of all the environmental conditions that can affect the health of wild populations. A multistep examination of the interactions between the host, pathogen(s), and environment involves the following: (1) identify and differentiate disease; (2) reproduce the disease under controlled conditions; (3) determine factors that may influence the pathogenicity of the infectious agent; (4) identify zones of high and low risk for infection; (5) correlate specific water quality factors with high and low risk sites; (6) reproduce the disease using the specific water quality risk factors; and (7) determine appropriate controls. (Vernooy-PTT)
W89-06051

FISH TUMORS AND ECOLOGICAL SURVEILLANCE: A CAUTIONARY EXAMPLE FROM PORT PHILLIP BAY,
British Industrial Biological Research Association, Carshalton (England).
G. C. Hard.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 975-980, October 1988. 4 fig, 6 tab, 27 ref.

Descriptors: *Bioindicators, *Water pollution effects, *Fish diseases, Animal pathology, Tumors, Pathology, Fish, Fish physiology, Parasitism, Carcinogens, Australia.

Interest in the development of strategies using faunal populations for monitoring chemical contamination of the environment was promoted, in part, by earlier investigations of skin lesions that were mistakenly diagnosed as epidermal papillomas in flatfish from Pacific coastal waters of the northern hemisphere. A survey aimed at exploring chemical pollution effects was also undertaken in the southern hemisphere in Port Phillip Bay, Australia, where over 15,000 fish, involving ten mainly bottom-feeding species, were sampled. Only two cases of true neoplasia (both in the sand flathead) were found, but there was a high prevalence of cancer-like growths in certain species of leatherjacket and a low prevalence in spiky globe fish. Morphological analysis proved these to be subacute inflammatory or chronic granulomatous reactions possibly due to parasitic infestation. These findings are discussed in relation to recent work that shows the epidermal papilloma to be a pseudotumor. The study underlines the need for caution in evaluating epizootic fish tumors. Accurate discrimination between nonneoplastic inflammatory or proliferative reactions and true neoplasia is critical for the identification of faunal indicators of environmental contamination by carcinogens. (Vernooy-PTT)
W89-06052

EFFECT OF BIOLOGICAL VARIABILITY ON MONITORING STRATEGIES: METALLOTHIONEINS AS AN EXAMPLE,
National Marine Fisheries Service, Beaufort, NC. Beaufort Lab.
For primary bibliographic entry see Field 5A.
W89-06053

FISH EMBRYOS: PRACTICAL INDICATORS OF ENVIRONMENTAL QUALITY OF SIGNIFICANCE TO FISHERIES,
National Marine Fisheries Service, Milford, CT. Milford Lab.
For primary bibliographic entry see Field 5A.
W89-06055

STRUCTURE AND SENSORY ANALYSES OF TAINTING SUBSTANCES IN FINNISH FRESHWATER ENVIRONMENTS,
Jyvaeskylae Univ. (Finland). Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-06107

PETROLEUM-LIKE OFF-FLAVOUR IN SEASONED HERRING ROE,
Nichiro Fisheries Co. Ltd., Kanagawa (Japan). Research Lab.
T. Sato, N. Matsuoka, H. Sugihara, H. Akazawa, and T. Motohiro.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 49-53, 1938. 4 fig, 6 ref.

Descriptors: *Styrene, *Taste, *Hydrocarbons, *Fish eggs, *Herring, *Pollutant identification, *Odors, *Water pollution effects, Organoleptic properties, Fish, Organic compounds, Aromatic compounds, Water quality, Yeasts, Chromatography, Gas chromatography, Mass spectrometry, Foods.

A petroleum-like off-flavor found in seasoned herring roe was implicated as styrene by head-space gas chromatography and gas chromatography-mass spectrometry. The styrene was not detected in the plastic packaging film or in samples of fresh and normal seasoned roe. However, one strain of yeast was isolated from an off-flavored sample of seasoned herring roe. The styrene was subsequently produced in a test seasoning solution into which the yeast isolate had been inoculated and incubated at 25 C. The yeast isolate was identified as Torulopsis candida. It is therefore suggested that occurrence of styrene in the seasoned herring roe be prevented by inhibiting the growth of T. candida in this food. However, the precursor of styrene and the origin of the microorganism are not yet known. These factors are under investigation. (Author's abstract)
W89-06108

POTENT ODOUR-CAUSING CHEMICALS ARISING FROM DRINKING WATER DISINFECTION,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5F.
W89-06109

CHEMISTRY OF OFF-FLAVOURS IN MARINE ORGANISMS,
Commonwealth Scientific and Industrial Research Organization, North Ryde (Australia). Div. of Food Research.
For primary bibliographic entry see Field 5B.
W89-06110

WATER BLOOMS OF UROGLENA AMERICANA AND THE IDENTIFICATION OF ODOROUS COMPOUNDS,
Kobe City Water Works Bureau (Japan). Water Quality Lab.
For primary bibliographic entry see Field 5A.
W89-06111

OFF-FLAVOR IN THE CHANNEL CATFISH (ICTALURUS PUNCTATUS) DUE TO 2-METHYLISOBORNEOL AND ITS DEHYDRATION PRODUCTS,
Mississippi State Univ., Mississippi State. Coll. of Veterinary Medicine.

For primary bibliographic entry see Field 5A.
W89-06114

CHEMICAL ECOLOGY AND OFF-FLAVOUR SUBSTANCES,
Norsk Inst. for Vannforskning, Oslo.
For primary bibliographic entry see Field 7B.
W89-06123

OVERVIEW OF ENVIRONMENTAL PROBLEMS IN THE EAST ASIAN SEAS REGION,
Philippines Univ., Diliman, Quezon City. Marine Science Inst.
For primary bibliographic entry see Field 6G.
W89-06168

LAKE ACIDIFICATION IN NORWAY: PRESENT AND PREDICTED CHEMICAL STATUS,
Norsk Inst. for Vannforskning, Oslo.
A. Henriksen, L. Lien, T. S. Traaen, I. S. Sevaldrud, and D. F. Brakke.
Ambio AMBOCX, Vol. 17, No. 4, p 259-266, 1988. 7 fig, 5 tab, 19 ref.

Descriptors: *Acid rain, *Norway, *Lakes, Neutralization, Sulfates, Hydrogen ion concentration, Acidic water, Air pollution, Cations, Aluminum, Path of pollutants, Nitrates, Chemical properties, Water quality, Bicarbonates.

The Thousand Lake Survey was conducted in Norway in the fall of 1986 to determine the chemical status of lakes in areas sensitive to acidic deposition. The survey was also designed to detect possible changes in water quality as a follow-up to extensive regional surveys which were conducted in 1974/1975. In large areas of southern Norway receiving acid precipitation, thousands of lakes and streams are acidic (ANC < 0). Large areas elsewhere in Norway contain lakes with low concentrations of base cations. These areas would also by expected to contain acidic lakes if they receive acidic loadings equivalent to those in southernmost Norway. The pH of lakes in southern Norway has changed little from 1974/1975 to 1986. Sulfate concentrations are significantly lower today in the most affected lakes in southernmost and eastern Norway, corresponding to reductions in emissions, but are still elevated. Nitrate concentrations in most of the lakes in Sorlandet have, however, doubled on average over the same period, while no significant changes have occurred in the rest of southern Norway. In the lakes with higher concentrations of nitrate in 1986, aluminum concentrations are also higher. At present, about 70% of the lakes sampled in southern Norway have lost all of their bicarbonate buffering capacity. With a 30% reduction from present levels of SO4 in lakes, this percentage should decline to about 55% and with a 50%- reduction about 45% of the lakes will be without bicarbonate buffering. (Author's abstract)
W89-06174

HUMAN EXPOSURE TO POLYCHLORINATED BIPHENYLS AT TOXIC WASTE SITES: INVESTIGATIONS IN THE UNITED STATES,
Center for Disease Control, Atlanta, GA.
P. A. Stehr-Green, V. W. Burse, and E. Welty.
Archives of Environmental Health AEHLAU, Vol. 43, No. 6, p 420-424, November-December 1988. 2 tab, 24 ref.

Descriptors: *Path of pollutants, *Polychlorinated biphenyls, *Public health, *Waste disposal, *Hazardous wastes, *Water pollution effects, *Well water, Groundwater pollution, Aromatic compounds, Soil contamination, Fish.

Beginning in 1982, environmental and population data were evaluated from waste sites contaminated with polychlorinated biphenyls (PCBs). Pilot exposure assessment studies were conducted at 12 sites where risks of human exposure were thought to be greatest. Serum PCB levels in persons at highest risk of nonoccupationally related exposures (because of their self-reported frequencies and types of activities in contaminated areas) at 10 sites were within background ranges, even though environmental contamination levels as high as 2.5 parts per billion (ppb) in monitoring well water samples and 330,000 ppb in soil samples were measured. At the two remaining sites, elevated serum levels were found in these high-risk persons, which require further evaluation by community surveys. These results illustrate that, despite elevated environmental contaminant levels, unless uptake of chemicals above background exposure levels can be demonstrated, adverse health effects cannot be attributed to waste site chemicals. However, health risks due to background exposure levels, as well as in populations with elevated PCB body burdens need further study. (Author's abstract)
W89-06175

EFFECTS OF IRON COMPOUNDS ON MACROINVERTEBRATE COMMUNITIES IN A DANISH LOWLAND RIVER SYSTEM,
Water Board of Vejle Amtskommune (Denmark).
K. Rasmussen, and C. Lindegaard.
Water Research WATRAG, Vol. 22, No. 9, p 1101-1108, September 1988. 5 fig, 3 tab, 19 ref.

Descriptors: *Environmental effects, *Iron, *Water pollution effects, *Macroinvertebrates, *Species diversity, *Denmark, Benthos, Water quality, Rivers, Leaching, Chironomids, Tubificids, Ecological effects, Hydrogen ion concentration, Insects.

The effects of iron compounds on the macroinvertebrate fauna were investigated in a Danish lowland river system (River Vidaa). As a result of industrial farming activities, water levels have been lowered and iron has leached into the rivers. Concentrations of annual average dissolved iron from 28 localities varied from about 0 to 32 mg Fe(2+)/L, while pH varied from 6.7 to 8.8. A negative correlation between numbers of taxa and concentration of dissolved iron is suggested. Sixty-seven taxa of macroinvertebrates were collected from sites where concentrations were below 0.2 mg Fe(2+)/L, however, between 0.2 and 0.3 mg Fe(2+)/L an abrupt drop to 53 taxa was recorded. Taxa eliminated were primarily grazers feeding on biofilm. Elimination of taxa continued up to 10 mg Fe(2+)/L, where about 10 taxa were left. Numbers of individuals declined at concentrations > 1 mg Fe(2+)/L. Ephemeroptera and Plecoptera were found only at low iron concentrations. The species found at highest iron concentrations belong to Tubificidae, Chironomidae and Tipulidae. (Author's abstract)
W89-06184

BIOACCUMULATION, DISTRIBUTION AND RETENTION OF NI63(2+) IN THE BROWN TROUT (SALMO TRUTTA),
Sveriges Lantbruksuniversitet, Uppsala. Dept. of Pharmacology and Toxicology.
For primary bibliographic entry see Field 5B.
W89-06187

ALGAL BIOASSAYS IN EUTROPHICATION RESEARCH: A DISCUSSION IN THE FRAMEWORK OF A MATHEMATICAL ANALYSIS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
For primary bibliographic entry see Field 5G.
W89-06226

VARIABILITY AMONG BLUEGILL VENTILATORY RATES FOR EFFLUENT TOXICITY BIOMONITORING,
Battelle Columbus Div., OH.
For primary bibliographic entry see Field 5A.
W89-06228

DOSING SYSTEM TO VARY PH, SALINITY, AND TEMPERATURE,
Maryland Univ., Baltimore. School of Medicine.
For primary bibliographic entry see Field 5A.
W89-06232

INFLUENCE OF GROWTH MEDIUM COMPOSITION ON THE TOXICITY OF CHEMICALS TO ALGAE,
Lancashire Polytechnic, Preston (England).
For primary bibliographic entry see Field 7B.
W89-06308

PATHOGENICITY OF ENVIRONMENTAL CAMPYLOBACTERS--A HUMAN VOLUNTEER EXPERIMENT,
Public Health Lab. Service, Hull (England). Hull Royal Infirmary.
S. L. Mawer.
Epidemiology and Infection, Vol. 101, No. 2, p 295-300, October 1988. 14 ref.

Descriptors: *Pathogenic bacteria, *Bacteria, *Human pathology, *Campylobacter, Human diseases, Infection, Bacterial analysis, Stream pollution.

Three human volunteer experiments were performed in which river water expected to contain campylobacter organisms was ingested. Despite the ingestion of over 44,000 organisms in one experiment, the subject did not suffer any symptoms, nor were campylobacter organisms excreted, nor was an antibody response to the ingested strains detected. The campylobacter organisms ingested resembled Campylobacter jejuni on colonial and microscopic morphology but were hippurate negative, and were distinct from C. coli. These environmental campylobacter strains appear to be nonpathogenic, however they may be mistaken for C. jejuni or C. coli if they are not fully identified. (See also W89-06310) (Author's abstract)
W89-06311

NUTRIENT DYNAMICS OF A SUBMERSED MACROPHYTE COMMUNITY IN A STREAM ECOSYSTEM DOMINATED BY POTAMOGETON PECTINATUS L.,
Rensselaer Polytechnic Inst., Troy, NY. Rensselaer Fresh Water Inst.
For primary bibliographic entry see Field 2H.
W89-06324

COMPARISON OF PLASMID DISTRIBUTION IN SEDIMENT BACTERIA ISOLATED FROM CLEAN AND NAPHTHALENE POLLUTED SITES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
M. J. Day, N. F. Burton, and A. T. Bull.
Letters in Applied Microbiology LAMIE7, Vol. 7, No. 3, p 71-73, September 1988. 1 fig, 1 tab, 14 ref. Science and Engineering Research Council Grant GR/B23229.

Descriptors: *Water pollution effects, *Rivers, *Aromatic hydrocarbons, *Sediments, *Bacteria, *Plasmids, Industrial wastes, Chemical wastes, Adaptation, Acclimatization, Hydrocarbons, Organic compounds, Naphthalene, Pseudomonas, Ely River, United Kingdom, Coking plant, Microbiological studies, Comparison studies, Distribution patterns, Whales.

Sediments were sampled in the River Ely, Wales, at sites above and below the naphthalene-polluted discharge from a 70-year old coking plant. A total of 9.4% of isolates from the clean site and 15.0% of those from the polluted site contained plasmids. The overall size distribution of the plasmids from both sites was similar. The frequency of multiple band isolates and the average number of plasmid bands per plasmid-containing isolate was slightly lower at the polluted (18%, 1.2 plasmids per isolate; n = 21) than at the clean site (24%, 1.4; n = 46). It was postulated that the local microbial population may have adapted to the effluent and stablized the genes for naphthalene catabolism onto the chromosome. (Cassar-PTT)
W89-06330

LEAD POISONING IN SWANS AND SOURCES OF CONTAMINATION IN IRELAND,
University Coll., Cork (Ireland). Dept. of Zoology.
J. O'Halloran, and A. A. Myers.
Journal of Zoology London (A) JZOOAE, Vol.

216, No. 2, p 211-223, October 1988, 2 fig, 5 tab, 45 ref.

Descriptors: *Water pollution sources, *Animal pathology, *Ireland, *Water pollution effects, *Path of pollutants, *Swans, *Lead, Ponds, Birds, Heavy metals, Wildlife, Toxicity, Waterfowl.

A study of blood in mute swans Cygnus olor in Ireland revealed that ingested lead p responsible for acute lead poisoning. Forty-two percent of blood samples from 890 live birds at one site showed elevated lead levels. X-ray examination of live birds revealed the source of contamination to be ingested lead pellets. Urban birds were shown to have higher ($p<0.001$) lead levels than rural birds, the blood levels of which were presumed to reflect natural background levels. Urban grass was shown to have elevated lead but this did not cause lead poisoning in Canada geese Branta canadensis. Post-mortem examination has shown that 68% ($n=101$) of all mute swans examined from a number of sites died from lead poisoning. Two sources of poisoning were identified; spent gunshot from a claypigeon shooting site at Lough Neagh, Northern Ireland, and lost or discarded anglers' weights at Cork Lough and at a fishing pond in Belfast, N.I. The first known case of lead poisoning in whooper swans Cygnus cygnus in Ireland is recorded which resulted from the ingestion of gunshot used almost two decades earlier. (Author's abstract)
W89-06332

WORMS, WELLS AND WATER IN WESTERN MADAGASCAR,
Southampton Univ. (England).
For primary bibliographic entry see Field 6G.
W89-06333

GEORGIAN BAY PHYTOPLANKTON ECOLOGY AND RESPONSE TO CONTAMINANTS,
Canada Centre for Inland Waters, Burlington (Ontario).
M. Munawar, and I. F. Munawar.
Hydrobiologia HYDRB8, Vol. 163, p 95-117, June 20, 1988. 12 fig, 8 tab, 36 ref.

Descriptors: *Toxicity, *Species composition, *Population density, *Water pollution effects, *Lakes, *Limnology, *Phytoplankton, *Productivity, *Bioassay, *Biomass, *Georgian Bay, *Lake Huron, Oligotrophic lakes, Primary productivity, Diatoms, Chrysophyta, Cyanophyta, Chlorophyll, Metals, Great Lakes, Water pollution sources.

The phytoplankton productivity of Georgian Bay was studied during 1974. Lakewide samples were collected at 16 stations during monthly cruises from April to December. Contaminant bioassays with metals added singly and as a mixture were performed in 1980 and 1981. Based on an overall average, Diatomeae (36-73%) was the most prevalent component of phytoplankton biomass, followed by Chrysophyceae (5-38%), and Cyanophyta (3-27%). Biomass means of all stations by cruise indicated a range of 0.35 to 0.61 g per cu m with a bimodal seasonal pattern. Although ultraplankton made the highest mean percent contribution to the biomass (37%), the other size assemblages such as <5 micrometers (26%) and netplankton (29%) were not unimportant. Size fractionation of primnary productivity during 1974 revealed that a major portion of photosynthesis (39-70%) was in the <20 micrometer size fraction. Algal fractionation bioassays conducted during 1980 and 1981 indicated a significant inhibition of ultraplankton productivity. Additional bioassays with single metals and in combination showed differential toxicity to various phytoplankton size assemblages. The phytoplankton biomass and floristic composition indicate the Georgian Bay ecosystem to be oligotrophic. This ecosystem appears to be controlled by the physical dynamics of thermal and flow regimes. Compared with other Great Lakes, the low production/biomass ratio recorded in oligotrophic Georgian Bay is enigmatic and may be attributable to the observed sensitivity of phytoplankton to contaminants originating from anthropogenic and natural sources. (See also W89-06335) (Author's abstract)
W89-06341

PHYCOLOGICAL STUDIES IN THE NORTH CHANNEL, LAKE HURON,
Canada Centre for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2H.
W89-06342

DOMINANT ATTACHED FILAMENTOUS ALGAE OF GEORGIAN BAY, THE NORTH CHANNEL AND EASTERN LAKE HURON: FIELD ECOLOGY AND BIOMONITORING POTENTIAL DURING 1980,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
For primary bibliographic entry see Field 2H.
W89-06345

EFFECTS OF REGULATED STREAM ON THE HYDROCHEMISTRY AND ZOOBENTHOS IN DIFFERENTLY POLLUTED PARTS OF THE UPPER VISTULA RIVER (SOUTHERN POLAND),
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
E. Dumnicka, H. Kasza, A. Kownacki, E. Krzyzanek, and T. Kuflikowski.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 183-191, November 21, 1988. 5 fig, 2 tab, 15 ref.

Descriptors: *Dam effects, *Poland, *Water pollution effects, *Rivers, *Reservoirs, *Environmental effects, *Benthic fauna, Vistula River, Wisla Czarne Reservoir, Goczalkowice Reservoir, Laczany Reservoir, Water quality, Reservoir releases, River regulations, Dams, Nitrogen, Phosphorus, Dissolved oxygen, Invertebrates, Organic matter, Oxygenation, Water flow, Water depth.

The water quality and benthic fauna were studied above and below three ecologically different dams on the Vistula River, Poland: Wisla Czarne (4.6 million cu m, 9 m deep, bottom outlet, unpolluted), Goczalkowice (168 million cu m, 5.3 m deep, bottom outlet, used for public water supply, downstream of sewage discharges), and Laczany (1.5 million cu m, 1.5 m deep, overflow outlet, heavily polluted). Water below the Wisla Czarne was enriched in ammonia nitrogen, phosphates, and organic matter. The zoobenthos population increased in detritophagous Simuliidae and Amphipoda. Goczalkowice Reservoir, with its low flow, trapped N and P in mineral form; fauna typical of slow-moving waters were found downstream (Mollusca, Hirudinea, Chironomidae). Water leaving Laczany by overspilling was oxygenated; however, pollution was not eliminated because of the short retention time. The zoobenthos population was similar upstream and below the dam. The factors influencing the benthic fauna population in these cases were water quality, flow rate, outlet location, reservoir depth, and water residence time. (Cassar-PTT)
W89-06351

BENTHIC NEMATODES IN ACIDIFIED LAKES: CASE OF A NEGLECTED GRAZER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
K. Prejs, and S. Lazarek.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 193-197, November 21, 1988. 1 fig, 1 tab, 27 ref.

Descriptors: *Acid rain effects, *Lime, *Water pollution effects, *Lakes, *Acidic water, *Benthic fauna, Nematodes, Invertebrates, Gardsjon Lake, Hastevatten Lake, Sweden, Lake Plastic, Canada, Hydrogen ion concentration, Benthic mat.

The abundance and composition of nematodes were examined in the benthic microbial mats and upper sediment layer of littoral areas in Gardsjon Lake (pH 4.67), Hastevatten Lake (pH 5.15) in Sweden and Lake Plastic (pH 5.7) in Canada. In Gardsjon nematodes constituted 58-90% of all the invertebrates present. The density of nematodes ranged from 530 to 10,550 individuals per gram dry weight or 2670 individuals per gram dry weight of benthic mat. The dominant taxa were Rhabdolaimus aquaticus, Eurmonhystera filiformis, Monhystera sp., and Ironus intermedius. In Hastevatten the composition of nematodes was similar except for a higher proportion of I. intermedius. Liming of Gardsjon dissolved the benthic mat and decreased the number of nematodes. As the mat reformed during the next three years, I intermedius gradually reappeared. (Cassar-PTT)
W89-06352

OBSERVATIONS ON THE RELATION BETWEEN PHYTOPLANKTON DIVERSITY AND ENVIRONMENTAL FACTORS IN THE VAAL RIVER AT BALKFONTEIN, SOUTH AFRICA,
Orange Free State Univ., Bloemfontein (South Africa). Dept. of Botany.
A. J. H. Pieterse, and J. M. van Zyl.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 199-207, November 21, 1988. 3 fig, 1 tab, 35 ref.

Descriptors: *Water pollution effects, *Rivers, *Species diversity, *Phytoplankton, *Turbidity, Vaal River, South Africa, Algae, Flow rate, River flow, Water quality, Sulfates, Nitrogen, Phosphorus, Silica, Dissolved solids, Statistical analysis.

The relationship between specific environmental factors as independent variables and temporal changes in phytoplankton community structure in the Vaal River (a turbid system) was investigated during 1984. The Shannon-Wie H' and Hurlbert PIE indexes were used. Phytoplankton diversity was primarily related to discharge and discharge derived variables (sulfate, silica, nitrogen, phosphorus) and secondarily to turbidity derived variables (euphotic zone depth). An August peak in total phytoplankton concentration (dominated by Stephanodiscus hantzschii fo. tenuis and Micractinium pusillum) was related to increased environmental stress, which reduced the number of sensitive species and allowed the tolerant species to increase in numbers. (Cassar-PTT)
W89-06353

RESPONSE OF MACROINVERTEBRATES TO EXPERIMENTAL EPISODES OF LOW PH WITH DIFFERENT FORMS OF ALUMINUM DURING A NATURAL SPATE,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
N. S. Weatherley, S. J. Ormerod, S. P. Thomas, and R. W. Edwards.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 225-232, November 21, 1988. 2 fig, 2 tab, 34 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Streams, *Macroinvertebrates, *Acidic water, *Aluminum, Toxicity, Hydrogen ion concentration, Benthic fauna, Invertebrates.

Twenty-four-hour experimental episodes were created in a soft-water stream in Wales by the simultaneous addition at separate points of sulfuric acid, aluminum sulfate, and citric acid. In the control zone upstream (A) pH remained above 7. In the treatment zones B, C, and D downstream pH was reduced to about 4.9. Concentrations of filterable aluminum were 0.05 mg/liter in Zone B, 0.27 mg/liter (0.11 mg/liter labile) in Zone C, and 0.23 mg/liter (zero labile) in Zone D. Chemical manipulation coincided with a spate, during which flow increased from 0.02 cu m/s to a maximum of 0.07 cu m/s. Only Baetis rhodani showed a drift response: drift density was not affected by flow (Zone A) or by organically bound aluminum, but increased 6-fold in both the acid (B) and labile aluminum (C) zones. The density of B. rhodani declined significantly in Zones C and D, by 78% and 89%, respectively. The influence of acidic water on drift was greater than those of flow. (Cassar-PTT)
W89-06354

ANALYSIS OF FACTORS CONTROLLING RESPONSES OF AN AQUATIC MICROCOSM TO ORGANIC LOADING,
Tohoku Univ., Sendai (Japan). Biological Inst.
S. Shikano, and Y. Kurihara.
Hydrobiologia HYDRB8, Vol. 169, No. 2, p 251-

257, November 21, 1988. 6 fig, 10 ref.

Descriptors: *Water pollution effects, *Organic loading, *Bacteria, *Algae, Ammonia, Cyclidium, Aeolosoma, Chlorella, Microenvironment.

The changes in the numbers of individuals of the constituent species and ammonia concentrations in six subsystems (bacteria, bacteria-Cyclidium, bacteria-Aeolosoma, bacteria-Chlorella, bacteria-Cyclidium-Chlorella, bacteria-Aeolosoma-Chlorella) of an aquatic microcosm were examined after the addition of organic substance (peptone) at both the young and mature stages of succession. Organic loading led to decreases in the numbers of bacteria and Aeolosoma after temporary increases in their numbers and an oscillation in the numbers of Cyclidium, but the densities of these populations were maintained at constant values in the presence of Chlorella. When organic substance was added at a young stage where the photosynthetic activities of algae were high, invertebrates, especially Aeolosoma, were damaged by unionized ammonia which was formed as the pH value increased. In contrast, organic loading at the mature stage enhanced the population densities and biomasses of all constituent species. (Author's abstract)
W89-06355

GENOTOXIC ACTIVITY OF ORGANIC CHEMICALS IN DRINKING WATER,
Health Effects Research Lab., Cincinnati, OH. Toxicology and Microbiology Div.
J. R. Meier.
Mutation Research MUREAV, Vol. 196, No. 3, p 211-245, November 1988. 2 tab, 173 ref.

Descriptors: *Water pollution effects, *Water treatment, *Literature reviews, *Drinking water, *Organic compounds, *Mutation, *Carcinogenesis, *Disinfection, Organic matter, Humic acids, Amino acids, Proteins, Pollutant identification, Sample preparation, Chlorine, Chlorine dioxide, Ozone, Chloramines, Cancer, Public health, Activated carbon, Adsorption, Dechlorination, Sulfur dioxide, Water storage, Water distribution, Storage, Water analysis, Ion exchange, Chromatography.

Substantial evidence for the widespread presence of genotoxins in drinking water is presented in this review. Most of these cases can be directly attributed to the chlorination stage of drinking water treatment, especially during the reaction of chlorine with humic substances in the raw water. This genotoxic activity has been demonstrated in drinking water concentrates using bacterial mutagenicity tests (Ames test) and mammalian cell assay systems. No evidence currently exists for genotoxic damage following in vivo exposures in animals. In some locations the contaminants of industrial or agricultural origin contribute to the genotoxic activity of treated drinking water. The method used for sample concentration can have an important bearing on study results. In particular, organic acids, which are responsible for most of the mutagenicity in chlorinated water, require an acidification step prior to extraction or XAD resin adsorption. Work on determination of the identity of the precursor compounds responsible for mutagenicity show that the chlorinated hydroxyfuranones are prominent. Sources of genotoxic substances are source water, disinfection byproducts, and the water storage/distribution system. Methods for reduction of genotoxic compounds in drinking water include granular activated carbon filtration, chemical destruction, and alternative means of treatment such as ozone, chlorine dioxide, and monochloramine. Activated carbon treatment is effective for removing mutagens even after extensive use. All disinfectant chemicals appear to have the capacity for forming mutagenic compounds during water treatment. However, levels of mutagenicity reached during the use of the alternative disinfectants are less than that of chlorine and highly dependent on the quality of the source water. It is concluded that exposure to chlorination byproducts in drinking water should be minimized while maintaining a microbiologically safe product. (Cassar-PTT)
W89-06366

RESPONSE OF HEADWATER LAKES TO VARYING ATMOSPHERIC DEPOSITION IN NORTH-CENTRAL ONTARIO, 1979-85,
Department of Fisheries and Oceans, Sault Ste. Marie (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
J. R. M. Kelso, and D. S. Jeffries.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1905-1911, November 1988. 4 fig, 5 tab, 29 ref.

Descriptors: *Lakes, *Water pollution sources, *Watersheds, *Acid rain, *Water quality control, *Sulfates, Atmospheric deposition, Ontario, Headwaters, Hydrogen ion concentration, Sucker, Fish migration.

Between 1976 and 1985, loadings of SO4(-2) to the Algoma district (north-central Ontario) varied from a low of 47 (1980) to a high of 84 meq/sq m (1978) and was low in years of low annual precipitation. The mean and median lake concentrations of H(+) and SO4(-2) in 54 lakes declined between 1979 and 1982 following the period of lowest annual deposition and declined further between 1982 and 1985. Overall, mean lake pH increased 0.35 units between 1979 and 1982 and an additional 0.07 units over the next 3 yr. Lake concentrations in the Turkey Lakes watershed exhibited a similar trend. Two lakes without fish in 1979 and with pH's < 5.5 developed white sucker (Catostomus commersoni) populations by 1986 with ages indicating that survival began after 1980. This apparent invasion from downstream populations probably occurred when lake pH's neared 5.5. Although a direct link has not been established, these lakes appear to be extremely responsive to changes in atmospheric deposition. The recovery of water quality clearly extends beyond that locally documented at Sudbury, Ontario, yet it remains to be determined to what degree the responses relate to differences in continental deposition and/or responses within the watershed. (Author's abstract)
W89-06376

FISH SPECIES RICHNESS IN RELATION TO LAKE AREA, PH, AND OTHER ABIOTIC FACTORS IN ONTARIO LAKES,
Ontario Ministry of Natural Resources, Toronto.
J. E. Matuszek, and G. L. Beggs.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1931-1941, November 1988. 7 fig, 4 tab, 44 ref.

Descriptors: *Acid rain effects, *Lakes, *Fish populations, *Species diversity, *Aluminum, Hydrogen ion concentration, Species composition, Chemical properties, Lake morphology, Ontario, Surveys, Dissolved solids, Organic carbon.

Survey data from 2931 Ontario lakes were analyzed to determine how fish species richness was empirically related to a set or 19 physical and chemical limnological variables. Lake are was the dominant factor, explaining 18% of the variation in species number. Total aluminum, latitude, dissolved organic carbon, and elevation together explained an additional 16%. The strong relationship between species number and lake area was quantified using lakes with pH > or = 6.4 and then applied to all the surveyed lakes to estimate species number. Deviations from the expected values indicated that species number decreased with decreasing pH below 6.0, resulting in significantly fewer species in lakes with pH < 6.0. In the subset of lakes with pH < 6.0, pH alone explained 21% of the variation in species number; elevation, lake area, and dissolved organic carbon together explained an additional 20%. Interactions between pH and lake area were identified; lake size decreased significantly both at low pH (<6.8) and at high pH (> or = 7.7). An understanding of these interactions was essential in explaining the relative roles of pH and lake area in determining species richness. (Author's abstract)
W89-06377

WHAT IS A SAFE LEVEL OF POLYCYCLIC AROMATIC HYDROCARBONS FOR FISH: SUBCHRONIC TOXICITY STUDY ON WINTER FLOUNDER (PSEUDOPLEURONECTES AMERICANUS),
Department of Fisheries and Oceans, St. John's (Newfoundland). Science Branch.
J. F. Payne, J. Kiceniuk, L. L. Fancey, U. Williams, and G. L. Fletcher.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 1983-1993, November 1988. 2 fig, 6 tab, 88 ref.

Descriptors: *Water pollution effects, *Hydrocarbons, *Toxicity, *Fish, *Flounders, *Aromatic compounds, Marine sediments, Coastal waters, Enzymes, Fish physiology.

Dose-response relationships were evaluated for a variety of biological and biochemical indices in a subchronic toxicity study with winter flounder (Pseudopleuronectes americanus) exposed to sediments contaminated with a petroleum source of polycyclic aromatic hydrocarbons (PAH). Indices investigated were biologically meaningful and included muscle and liver levels of energy reserves, organ weight-body weight relationships, and general condition indices. The hypothesis that many point sources of sediment hydrocarbon contamination worldwide could be harmful to fish health is supported. Biochemical effects such as change in mixed-function oxygenase (MFO) enzyme levels and fat content of liver were altered at very low hydrocarbon levels (about 1.0 microg/g), levels that will likely be found in sediments over much wider geographical areas than polluted harbors, or oil development and sewage outfall sites. Hydrocarbons in both coastal waters and food species may occur often in sufficient concentrations to affect biological responses in fish. The fact that very low levels of hydrocarbons in sediments, water, or foods may produce biological responses in fish attests to the importance of developing criteria for assessing the toxicological significance of sublethal effects of otherwise defining genuine harmful effects in contrast with effects per se. (Author's abstract)
W89-06380

SEASONAL VARIATION IN FAUNAL DISTRIBUTION WITHIN THE SEDIMENTS OF A CANADIAN SHIELD STREAM, WITH EMPHASIS ON RESPONSES TO SPRING FLOODS,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 2E.
W89-06381

IMPACT OF HEAVY METALS ON INSECT COMMUNITIES IN STREAMS: A COMPARISON OF OBSERVATIONAL AND EXPERIMENTAL RESULTS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Environmental and Hazardous Material Studies.
W. H. Clements, D. S. Cherry, and J. Cairns.
Canadian Journal of Fisheries and Aquatic Sciences CJFSDX, Vol. 45, No. 11, p 2017-2025, November 1988. 7 fig, 1 tab, 27 ref.

Descriptors: *Water pollution effects, *Streams, *Heavy metals, *Aquatic insects, *Macroinvertebrates, *Ecosystems, *Toxicity, Copper Zinc, Midges.

The effects of heavy metals on macroinvertebrate communities in outdoor experimental streams is compared with those observed at impacted field sites. Natural assemblages of aquatic macroinvertebrates were established on substrate-filled trays which were then transferred to outdoor stream mesocosms. Exposure of these communities to low levels of copper and zinc (target concentration = 12 microg/L) significantly reduced the number of taxa, number of individuals, and abundance of most dominant taxa within 4 days. After 10 days, control streams were dominated by Ephemeroptera and Tanytarsini chironomids, whereas treated streams were dominated by Hydropsychidae and Orthocladiini. Responses of Benthic communities to metals observed at the Clinch River (Russell Co., Virginia), a system impacted by copper and zinc, were similar to those in experimental streams. Ephemeroptera and Tanytarsini, which comprised 38-46% of the macroinvertebrate community at upstream reference stations, were significantly re-

duced at all effluent sites. As in treated experimental streams, impacted stations were dominated by Hydropsychidae ad Orthocladiini. The similarity of these experimental results to those obtained form the Clinch River field sites suggests that outdoor stream mesocosms may be employed to predict macroinvertebrate community responses to heavy metals. (Author's abstract)
W89-06383

ACIDIC CLOUD WATER AND CATION LOSS FROM RED SPRUCE FOLIAGE,
Tennessee Valley Authority, Muscle Shoals, AL. Air Quality Branch.
J. D. Joslin, C. McDuffie, and P. F. Brewer.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 355-363, June 1988. 2 fig, 1 tab, 27 ref.

Descriptors: *Acid rain effects, *Air pollution effects, *Forest decline, *Coniferous forests, *Spruce trees, *Cloud liquid water, *Nutrients, Deficient elements, Cation loss, North America, Europe, Throughfall, Sulfates, Nitrates, Chlorides, Hydrogen ion concentration, Ammonia.

Declines of red and Norway spruce in North America and Europe are occurring at high elevations where cloud interception is a major source of water and chemical deposition and the mean pH of cloud water is markedly lower than that of rainfall. At the summit of Whitetop Mountain (1700 m) in the southern Appalachians the chemistry of ambient cloud water was compared on a cloud event basis to that of cloud water-generated throughfall from red spruce saplings. Large shifts occurred in the relative importance of all the cations measured as cloud water became throughfall, whereas the relative importance of the major anions (SO4(2-), NO3(-), Cl(-)) remained relatively constant. Hydrogen ion and NH4(+) percentage contributions were reduced to two-third and one-third of their original percentages, respectively, whereas the other 4 major cations (K(+), Na(+), Mg(2+), Ca(2+) all at least doubled in importance. Losses of Ca and Mg from native red spruce foliage were observed to intensify markedly with increases in the acidity of cloud water. On sites where the available pools of certain cations are already marginal, losses of cations caused by acidic cloud water may contribute to nutrient deficiencies. (Author's abstract)
W89-06392

CHRONIC TOXICITY OF TRIBUTYLTIN TO CHESAPEAKE BAY BIOTA,
Johns Hopkins Univ., Shady Side, MD. Aquatic Ecology Section.
L. W. Hall, S. J. Bushong, M. C. Ziegenfuss, W. E. Johnson, and R. L. Herman.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 365-376, June 1988. 1 fig, 5 tab, 19 ref.

Descriptors: *Water pollution effects, *Chesapeake Bay, *Estuarine environment, *Aquatic animals, *Toxicity, *Tributyltin, Amphipods, Fish, Bays, Marinas, Sublethal effects.

Chronic tributyltin (TBT) toxicity experiments were conducted with the following Chesapeake Bay organisms: amphipod, Gammarus sp.; juvenile Atlantic menhaden, Brevoortia tyrannus and larval inland silverside, Menidia beryllina. TBT concentrations ranging from 29 to 579 ng/L did not significantly affect survival of the benthic amphipod, Gammarus sp. after 24-day exposures. The weight of Gammarus exposed to control conditions was 2.8 times greater than the weight of these test organisms exposed to 579 ng/L TBT. Twenty-eight day exposures to TBT concentrations of 93 and 490 ng/L did not significantly affect survival of juvenile B. tyrannus or larval M. beryllina. Histological examinations of B. tyrannus did not demonstrate absolute effects resulting from TBT exposure due to extensive variation between individuals. Various morphometric measurements of M. beryllina after TBT exposure did not demonstrate significant effects. However, significant reductions in growth were reported for M. beryllina at both TBT concentrations. Environmental concentrations of TBT in Chesapeake Bay marinas (51-408 ng/L) would likely produce no direct mortality with the three test species after 4 wk of exposure but sublethal effects such as growth inhibition may occur at mean concentrations reported in the various marina areas if prolonged exposures occurred. Mean environmental TBT concentrations in non-marina areas would not cause direct mortality to Chesapeake Bay fish or benthic invertebrates. (Brock-PTT)
W89-06393

BIOLOGICAL TESTS FOR THE ASSESSMENT OF EUTROPHICATION IN RUNNING WATERS,
Bundesanstalt fuer Gewaesserkunde, Koblenz (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W89-06418

ACIDIFICATION OF THREE MOORLAND POOLS IN THE NETHERLANDS BY ACID PRECIPITATION AND EXTREME DROUGHT PERIODS OVER SEVEN DECADES,
Rijksinstituut voor Natuurbeheer, Leersum (Netherlands).
H. Van Dam.
Freshwater Biology FWBLAB, Vol. 20, No. 2, p 157-176, October, 1988. 6 fig, 7 tab, 102 ref. Beijerinck-Popping Foundation of the Royal Netherlands Academy of Sciences and the European Community Contract ENV-650-N(N).

Descriptors: *Acidic water, *Ponds, *Wetlands, *Acid rain, *Drought, *Netherlands, Nitrogen compounds, Sulfur compounds, Hydrogen ion concentration, Water depth, Macrophytes, Diatoms, Marsh plants, Desiccation, Oxidation, Sediments.

Relations between acidification by atmospheric deposition, water depth and the occurrence of dry summers in this century, as well as their effects on chemistry, macrophytes and diatoms in three moorland pools, are described. Direct observations and biological data indicate a decrease of pH by about 0.5 unit over a period of 7 decades in a pool where 20% of the bottom desiccates in extremely dry years, and 2 pH units over the same period in a pool where 70% of the bottom is exposed to the atmosphere in such years. Acidification promotes the growth of Juncus bulbosus, Sphagnum and the acidobiontic diatom Eunotia exigua, and suppresses the growth of isoetids (e.g Lobelia dortmanna) and of acidophilous and circumneutral diatoms. Also the acidobiontic Frustulia rhomboides var. saxonica and Navicula subtilissima, characteristic of humic waters, decline by acidification. In two pools where more than half of the bottom desiccated in 1976, observed concentrations of sulfate were highest in 1977-78 and decreased later on. J. bulbosus had a maximum in 1977-80. E. exigua became the dominant diatom after 1976 and decreased after 1981 in the pool with the shortest residence time (3 years). In desiccating pools the long-term decrease of pH is apparently much larger than in softwater lakes in Scandinavia and North America. During the last 50 years, pH dropped rapidly after dry summers, probably due to oxidation of S and N compounds which were originally derived from the atmosphere, reduced and stored in the sediments. Rapid falls in pH were followed by an increase, presumably due to alkalinity production during sulfate reduction and denitrification. (Author's abstract)
W89-06442

ACUTE TOXICITY OF FURAZOLIDONE ON ARTEMIA SALINA, DAPHNIA MAGNA, AND CULEX PIPIENS MOLESTUS LARVAE,
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
A. Macri, A. V. Stazi, and G. Dojmj Di Delupis.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 90-94, October 1988. 1 tab, 9 ref.

Descriptors: *Antibiotics, *Furazolidone, *Farm wastes, *Toxicity, *Daphnia, *Mosquitoes, *Aquatic insects, Feeds, Bioaccumulation, Food chains, Water pollution effects, Antibiotics, Crustaceans, Nitrogen compounds.

As a result of evidence of the ecotoxicity of nitrofurans, the acute toxicity of furazolidone, an antibiotic used as an animal feed additive, was tested in vivo on two aquatic crustaceans, Artemia salina and Daphnia magna. Toxicity studies were also performed on larvae of Culex pipiens molestus. Results indicated a significant toxicity of the compound on C. pipiens and D. magna, while A. salina proved to be the least sensitive. Several hypothesis are proposed to explain the differences in toxicity among the tested species. One theory is based on the possibility of a slowing of the ingestion process of the solution by the tested organisms caused by the toxic substance. A second hypothesis is based on the different filtration characteristics of the test organisms. D. magna and C. pipiens larvae represent key food chain species and their disappearance could lead to an alteration of existing equilibria. (Geiger-PTT)
W89-06469

CARBOFURAN-INDUCED HISTOPHYSIOLOGICAL CHANGES IN THYROID OF THE TELEOST FISH, CHANNA PUNCTATUS (BLOCH),
Banaras Hindu Univ., Varanasi (India). Centre of Advanced Study in Zoology.
R. N. Ram.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 106-113, October 1988. 7 fig, 1 tab, 30 ref.

Descriptors: *Carbamate pesticides, *Toxicity, *Fish, *Carbofuran, Water pollution effects, Fish physiology, Bioaccumulation, Radioactive tracers, Animal pathology.

The long-term toxic effects of continuous exposure for 6 months, from January to June, to a safe dose (4.5 ppm) of a commercial carbamate pesticide, carbofuran, on the histophysiology of thyroid in adult and young (yearling) Channa punctatus, are described in this investigation. In both the experimental groups, thyroid histology exhibited various abnormalities including hypertrophy, hyperplasia and degeneration of follicular epithelial cells, and reduction in colloid content. Apart from this, in young experimentals, fibrosis of thyroid components, formation of cystic cellular masses, and rupture of blood vessels resulting in hemorrhage can also be seen and suggest direct action of this pesticide on the thyroid. On the other hand, in both treated groups, retardation of thyroid function was also evidenced by significantly reduced thyroidal radioiodine (I131) uptake and Cr (conversion ratio of protein-bound I131 in blood serum in relation to total serum I131 uptake) values. Apparently, these histopathological and physiological changes were markedly pronounced in young experimentals, suggesting greater susceptibility of this group to chronic toxicity of carbofuran than that of adults. Thus, on the basis of these results, it can be inferred that carbofuran pesticide, which is washed into water systems in small quantities, induces adverse histophysiological alterations in thyroid, in an age-dependent and size-dependent manner, possibly by acting directly on thyroid and/or through the hypothalamo-pituitary-thyroid axis, in this species. (Author's abstract)
W89-06471

EFFECT OF MALATHION AND ENDOSULFAN ON BRAIN ACETYLCHOLINESTERASE AND OVARIAN STEROIDOGENESIS OF CHANNA PUNCTATUS (BLOCH),
Banaras Hindu Univ., Varanasi (India). Dept. of Zoology.
R. M. Inbaraj, and S. Haider.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 123-128, October 1988. 6 fig, 26 ref.

Descriptors: *Insecticides, *Malathion, *Endosulfan, *Fish, *Toxicity, Enzymes, Organochlorine pesticides, Fish physiology, Organophosphorus pesticides, Fish eggs, Water pollution effects, Dehydrogenase.

The effect of sublethal concentrations of malathion (organophosphorus insecticide) and endosulfan (or-

ganochlorine insecticide) was investigated in Channa punctatus. Brain acetylcholinesterase (AcChE) and ovarian Delta-5,3 beta-hydroxysteroid dehydrogenase (HSD) and glucose-6-phosphate dehydrogenase (G-6-PD) activities were studied in fish exposed to the insecticides in laboratory aquaria. Apart from the loss of stage II and III oocytes, the absence of HSD and G-6-PD activity indicating the inhibition of steroidogenesis was seen in the malathion- and endosulfan-treated fish ovaries. Malathion demonstrated a dose-dependent inhibition of brain AcChE activity, whereas endosulfan caused no significant reduction of AcChE activity. (Author's abstract)
W89-06472

HERBICIDAL TRIAZINES: ACUTE TOXICITY ON DAPHNIA, FISH, AND PLANTS AND ANALYSIS OF ITS RELATIONSHIPS WITH STRUCTURAL FACTORS,
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
S. Marchini, L. Passerini, D. Cesareo, and M. L. Tosato.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 148-157, October 1988. 6 tab, 11 ref.

Descriptors: *Herbicides, *Daphnia, *Fish, *Algae, *Triazine pesticides, *Toxicity, *Structure-activity relationships, Photosynthesis, Molecular structure, Crustaceans, Aquatic plants.

The 24-hr and 48-hr EC50 immobilization test of Daphnia magna was performed on 14 herbicidal triazines characterized by structural differences with respect to the substituent groups at the three carbon atoms in the s-triazinic ring. EC50 values of the tested compounds were found to vary within a factor of 6 to 7; such variations of toxicity have been analyzed in terms of structural variations concerning: (1) the type of substituents, i.e., Cl, SCH3, or OCH3, at the carbon atom C-2, and (2) the number and size of the alkyl groups at the aminic nitrogen atoms bound to the ring carbons C-4 and C-6. Literature data relative to the acute toxicity of the considered herbicides on fish and plants were also analyzed with reference to the above structural features. The possibility that separate contributions to toxic effects of triazines are provided by specific groups bound to the common structural moiety, constituted by the 1,3,5-triazinic ring, is examined and discussed. (Author's abstract)
W89-06474

APPROACHES TO MODELING TOXIC RESPONSES OF AQUATIC ORGANISMS TO AROMATIC HYDROCARBONS,
Istituto di Ricerca sulle Acque, Brugherio (Italy).
S. Galassi, M. Mingazzini, L. Vigano, D. Cesareo, and M. L. Tosato.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 158-169, October 1988. 5 fig, 5 tab, 18 ref.

Descriptors: *Structure-activity relationships, *Trout, *Daphnia, *Toxicity, *Model studies, *Aromatic compounds, Benzenes, Mathematical models, Regression analysis, Comparison studies.

Acute toxic effects on Salmo gairdneri, Poecilia reticulata, Daphnia magna, and the growth inhibition of Selenastrum capricornutum were measured for eight aromatic hydrocarbons. Toxicity measurements were carried out following the OECD standard guidelines modified as appropriate in order to prevent hydrocarbon loss by volatilization; the concentrations of the substrates in the test solutions were periodically measured by HPLC. The toxic responses were analyzed in terms of the n-octanol/water partition coefficients, by means of linear regression analysis, and in terms of five molecular properties simultaneously, by means of the partial least squares analysis in latent variables (PLS). The univariate and multivariate quantitative structure-activity relationship models (QSAR) obtained by the two approaches are compared and discussed. The multivariate approach, carried out by means of PLS, provides more significant models than the Hansch-type approach. Furthermore, the information drawn from the PLS analysis may provide the basis for refining and expanding the QSAR, improving their predictivity, and assessing their field of application. (Author's abstract)
W89-06475

XENOBIOTIC METABOLIZING ENZYME SYSTEMS IN TEST FISH: III. COMPARATIVE STUDIES OF LIVER CYTOSOLIC GLUTATHIONE S-TRANSFERASES,
Istituto Superiore di Sanita, Rome (Italy). Lab. di Tossicologia Comparata ed Ecotossicologia.
L. Donnarumma, G. De Angelis, F. Gramenzi, and L. Vittozzi.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 2, p 180-186, October 1988. 2 fig, 1 tab, 23 ref.

Descriptors: *Detoxification, *Biotransformation, *Toxicity, Enzymes, Fish physiology, Water pollution effects, Liver, Trout, Carp, Bluegills, Guppies.

A major role in differential susceptibility of the test fish to the toxic effects of selected environmental contaminants may be played by the species-specific lack of iso-enzymes supporting the transformation of particular compounds, including some epoxides. The reduced glutathione (GSH)-conjugating capacities of the livers of trout, carp, zebra fish, guppy, and bluegill have been evaluated with several substrates preferentially metabolized by the major GSH-transferase isozymes. Carp and zebra fish lack GSH-transferase activity with 1,2-epoxy-3-(p-nitrophenoxy) propane. Guppy is characterized by the highest activities with 1-chloro-2,4-dinitrobenzene and the absence of activity toward trans-4-phenyl-3-buten-2-one. Enzyme activities with the other substrates demonstrate quantitative interspecific differences which presumably are of minor relevance to the metabolism and toxicity of chemicals. (Author's abstract)
W89-06476

VERTICAL DISTRIBUTION OF BROWN TROUT (SALMO TRUTTA) AND PERCH (PERCA FLUVIATILIS) IN AN ACIDIFIED LAKE,
Hedmark County Environmental Administration, Hamar (Norway).
A. Linlokken.
Water, Air, and Soil Pollution WAPLAC, Vol. 40, No. 1-2, p 203-213, 1988. 5 fig, 2 tab, 48 ref.

Descriptors: *Acid rain effects, *Trout, *Acidic water, *Perch, *Lakes, Spatial distribution, Hydrogen ion concentration, Thermocline, Spawning, Water pollution effects, Vertical distribution, Epilimnion, Aluminum, Juvenile growth stage, Acid rain, Acidic streams.

Brown trout (Salmo trutta) and perch (Perca fluviatilis) had different vertical distributions throughout the year in the acidified lake Gjerstadvann. During summer, the brown trout lived in the 0 to 16 m depth interval, whereas the perch lived in the 0 to 8 m interval. In Gjerstadvann, the thermocline lies at 8 to 10 m depth. The epilimnion pH was usually >5.6, and the thermocline pH was about 5.2. Brown trout and perch in Gjerstadvann, thus experienced different chemical environment during summer-stratification. Two rivers, one of them acidified, the other circum-neutral, were the most important spawning areas for the Gjerstadvann brown trout. Brown trout parr in the acidified river migrated to the lake and matured at younger ages than the brown trout spawning in the non-acidic river. The brown trout stocks were juvenilized because of low survival rate of adult fish (S = 0.15 to 0.19). The short life span was probably due to low pH and elevated Al. The perch in Gjerstadvann showed fluctuating year class strength but the survival rate of adult perch (S = 0.57) did not seem to be affected by acidification during this investigation. This may due to its vertical distribution during summer. (Author's abstract)
W89-06493

CARBOFURAN-INDUCED HISTOPATHOLOGICAL AND BIOCHEMICAL CHANGES IN LIVER OF THE TELEOST FISH, CHANNA PUNCTATUS (BLOCH),
Banaras Hindu Univ., Varanasi (India). Centre of Advanced Study in Zoology.
R. N. Ram, and S. K. Singh.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 194-201, December 1988. 8 fig, 1 tab, 24 ref.

Descriptors: *Toxicity, *Pesticides, *Carbamate pesticides, *Pesticide toxicity, *Fish physiology, *Water pollution effects, Histology, Liver, Insecticides, Biochemistry, Enzymes.

In Channa punctatus exposed to a safe dose (4.5 ppm) of the commercial carbamate pesticide carbofuran for 6 months, from January to June, liver exhibited varying degrees of histopathological changes including cytoplasmolysis, nuclear pyknosis, and necrosis leading to complete exhaustion and disintegration of hepatocytes. In some regions of liver, extensive degeneration of proliferated hepatocytes, in close proximity to blood sinuses, looking like darkly stained debris of hepatomass and induction of tumors were indicative of carcinogenic action of this pesticide which may be attributed to its cumulative toxicity during chronic exposure. Apart from this, the rupturing of blood sinus causing invasive infiltration of leukocytes, and detrimental focal necrosis resulting in the complete dissolution of hepatocytes indicated by the presence of debris mass in the necrotic space can be seen. In the liver of experimental fish, corresponding to cellular damage, a significant decrease in hepatosomatic index and ascorbic acid content and an elevation in acid and alkaline phosphatase levels were also recorded. These results suggest that carbofuran is capable of inducing histopathological and biochemical alterations in liver which may cause physiometabolic dysfunction in this species. (Author's abstract)
W89-06521

SUBCHRONIC METABOLIC EFFECTS AND TOXICITY OF A SIMULATED PULP MILL EFFLUENT ON JUVENILE LAKE TROUT, SALMO TRUTTA M. LACUSTRIS,
Joensuu Univ. (Finland). Dept. of Biology.
A. Oikari, P. Lindstrom-Seppa, and J. Kukkonen.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 202-218, December 1988. 2 fig, 7 tab, 50 ref. Academy of Finland/Research Council for the Environmental Sciences project 06/085.

Descriptors: *Trout, *Toxicity, *Fish physiology, *Pulp wastes, *Water pollution effects, Juvenile growth stage, Metabolism, Sulfates, Soaps, Fatty acids, Resins, Phenols, Enzymes, Growth, Mortality.

Juvenile lake trout (Salmo trutta m. lacustris) were exposed for 7 wk to 0.05 x and 0.2 x 96-hr LC50 concentrations of simulated bleached kraft pulp mill effluent (KME - Sa + CP). A sulfate soap preparation, composed mainly of resin and fatty acids, with added chlorophenols (CP, tri-, tetra-, and penta-CP) was used as the toxicant mixture. Concentrations of free CP in plasma and free and conjugated CP in bile were proportional to their concentrations in the water. The greatest total gradient between bile and water CP was 52,000 for pentachlorophenol. The activity of a liver polysubstrate monooxygenase (PSMO) system, assayed with three model substrates, increased 40 to 67% due to KME - Sa + CP. However, the increase was not directly dependent on the exposure concentration. In contrast to PSMO, activities of conjugating enzymes (p-nitrophenol UDP-glucuronosyl and glutathione transferases) were decreased in the liver. Increased concentration of glutathione was noted in the liver and kidney. In addition, a small (9%) but significant decrease in blood hemoglobin concentration was observed at the higher exposure concentration. Although growth rate of lake trout was markedly decreased due to KME - Sa + CP, hydromineral balance and carbohydrate metabolism in fish were unaffected, indicating possible physiological compensation. On the other hand, lethality tests with lake trout preexposed to KME - Sa + CP at 0.2 x LC50 revealed decreased

tolerance, whereas at the lower exposure concentration it was unchanged. It is concluded that various physiological adjustments in trout during subchronic exposures were not adaptive in terms of short-term tolerance. (Author's abstract)
W89-06522

DOSE-RELATED CARCINOGENIC EFFECTS OF WATER-BORNE BENZO(A)PYRENE ON LIVERS OF TWO SMALL FISH SPECIES,
Gulf Coast Research Lab., Ocean Springs, MS.
W. E. Hawkins, W. W. Walker, R. M. Overstreet, T. F. Lytle, and J. S. Lytle.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 219-231, December 1988. 14 fig, 6 tab, 22 ref.

Descriptors: *Carcinogens, *Water pollution effects, *Liver, *Aromatic compounds, *Hydrocarbons, *Fish, *Toxicity, Guppies, Histology, Metabolism, Fish physiology, Gills, Benzopyrene.

Benzo(a)pyrene (BaP) administered by water-borne exposures caused dose-related carcinogenic effects in livers of two small fish species, the Japanese medaka (Oryzias latipes) and the guppy (Poecilia reticulata). Medaka and guppies each were given two 6-h exposures. The first exposure was conducted on 6-day-old to 10-day-old specimens. The second exposure was given 7 days later. The tests incorporated five treatment groups: (1) control, (2) carrier (dimethylformamide) control, (3) low BaP dose (not detectable, 4 ppb), (4) intermediate BaP dose (about 8-47 ppb BaP), and (5) high BaP dose (200-270 ppb). Following the high-dose exposure, hepatocellular lesions classified as foci of cellular alteration (altered foci), adenomas, and hepatocellular carcinomas occurred in both species. In medaka, the lesions appeared to develop sequentially with the appearance of altered foci followed by adenomas and then hepatocellular carcinomas. Most lesions in guppies, however, were classified as altered foci although a few adenomas occurred in the early (24-week) sample and hepatocellular carcinomas occurred in the late (52-week) sample. When total lesions were combined, medaka had an 11% incidence at 24 weeks after the initial exposure and 36% incidence at 36 weeks. In guppies, 8% had liver lesions at 24 weeks, 19% at 36 weeks, and 20% at 52 weeks. A single extrahepatic neoplasm, a capillary hemangioma in a gill filament, occurred in a medaka from the 36-week high-dose sample. The results suggest that the medaka and guppy are capable of metabolizing water-borne BaP to carcinogenic metabolites which initiate hepatic tumor development. (Author's abstract)
W89-06523

HEPATIC MONOOXYGENASE INDUCTION AND PROMUTAGEN ACTIVATION IN CHANNEL CATFISH FROM A CONTAMINATED RIVER BASIN,
Louisiana State Univ., Baton Rouge. Inst. for Environmental Studies.
G. W. Winston, B. S. Shane, and C. B. Henry.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 258-271, December 1988. 7 fig, 2 tab, 35 ref.

Descriptors: *Toxicity, *Enzymes, *Fish physiology, *Water pollution effects, *Catfish, Liver, River basins, Water pollution, Metabolism, Devil's Swamp, Louisiana, Aromatic compounds, Chlorinated hydrocarbons, Polychlorinated biphenyls, Bioaccumulation, Insecticides, Mutagens.

The impact of environmental contaminants on xenobiotic metabolism of channel catfish (Ictalurus punctatus) from a highly polluted water body, Devil's Swamp in southeastern Louisiana, has been investigated in order to understand better the etiology of cancer in fish from polluted waters. Fish from Devil's Swamp bioaccumulated polynuclear aromatic hydrocarbons (PAH), chlorinated hydrocarbon insecticides (CHI), and polychlorinated biphenyls (PCB) in fat tissue, the fat tissue exceeding 7000 ppb. Reference catfish from the University farm, Ben Hur, were virtually devoid of PAH, CHI, and PCB. Liver microsomal enzymes (MFO) from Devil's Swamp fish were markedly induced. The specific content of cytochromes P450 and b5 and the specific activities of NAD(P)H-cytochrome c reductase were two to three times higher than those of Ben Hur fish. Consistent with this induction, a 9000g supernatant from Devil's Swamp but not Ben Hur fish activated 2-aminofluorene and benzo(a)pyrene (BP) to mutagens in the Ames test. BP metabolism by Devil's Swamp fish liver microsomes was inhibited to a greater extent by alpha-naphthoflavone than was BP metabolism by Ben Hur fish microsomes. This finding indicates that the induced activity in the Devil's Swamp fish liver was the result of P450 isozymes characteristic of PAH/PCB induction. Thus, exposure of fish to environmental pollutants can alter MFO leading to enhanced metabolic activation of promutagens to mutagens. (Author's abstract)
W89-06525

USE OF ALGAL FLUORESCENCE FOR DETERMINATION OF PHYTOTOXICITY OF HEAVY METALS AND PESTICIDES AS ENVIRONMENTAL POLLUTANTS,
Quebec Univ., Trois-Rivieres. Centre de Recherche en Photobiophysique.
For primary bibliographic entry see Field 5A.
W89-06526

METHOD FOR EVALUATING EFFECTS OF TOXIC CHEMICALS ON THE PRODUCTIVITY OF FRESHWATER ECOSYSTEMS,
Shell Research Ltd., Sittingbourne (England).
N. O. Crossland.
Ecotoxicology and Environmental Safety EESADV, Vol. 16, No. 3, p 279-292, December 1988. 15 tab, 12 ref.

Descriptors: *Pesticides, *Water pollution effects, *Aquatic productivity, *Ecological effects, *Bioindicators, *Trout, *Toxicity, *Organophosphorus pesticides, Aquatic environment, Productivity, Invertebrates, Sampling, Growth, Toxicity, Ponds, Insecticides, Standing crops, Fish.

The finding that trout apparently consumed more invertebrates than were produced in the Horokiwi stream has been described as 'Allen's paradox.' One explanation for this is that invertebrate sampling techniques underestimate the standing crop. If so, trout growth might be a relatively sensitive indicator of the effects of toxic chemicals on the productivity of experimental ponds. In a replicated pond experiment, methyl parathion was applied at concentrations toxic to invertebrates but not to fish. Three 50-cu m ponds were treated at 40 micrograms/L and three at 10 micrograms/L, and there were three untreated controls. Each pond was stocked with eight small, individually marked rainbow trout. The fish were removed by electrofishing 3 weeks after treatment. Mean growth rate of fish in control ponds was 6.3% per day, 4.3% per day in ponds treated with 10 micrograms/L, and 3.7% per day in ponds treated with 40 micrograms/L. Effects were significant at the 1% level. The standing crop of invertebrates was apparently insufficient to support the growth of the fish, an indication that the active, predatory rainbow trout is more efficient at sampling invertebrates than standard limnological procedures. (Author's abstract)
W89-06527

PHOSPHORUS TOXICITY IN CHARA,
Lund Univ. (Sweden). Inst. of Ecology.
I. Blindow.
Aquatic Botany AQBODS, Vol. 32, No. 4, p 393-395, December 1988. 1 fig, 9 ref.

Descriptors: *Water pollution effects, *Light penetration, *Phosphorus, *Toxicity, *Chara, *Eutrophication, Chlorophyta, Algae, Growth, Culturing techniques, Phosphates.

Characeans are often the first submerged macrophytes to disappear during eutrophication. As phosphorus toxicity is a common explanation for this decline, the growth rate of Chara spp. at high phosphorus concentrations was studied in the laboratory. Chara tomentosa and C. hispida were collected from lakes and ponds in southern Sweden and exposed to high concentrations of phosphorus (as Na2HPO4) in aerated water under continuous light. No significant differences (t-test) in shoot growth were found between treated plants and untreated controls. It is suggested that phosphorus toxicity previously reported for C. globularis may have been due to different responses from reproductively isolated populations of that species. However, even if the observation of phosphorus toxicity in C. globularis is not an artifact, the conclusion that characeans disappear in eutrophicated waters because of phosphorus toxicity may be too general. In lakes with total phosphorus concentrations > 20 microg/L, Secchi depths were lower owing to increased phytoplankton biomass. Therefore, it is assumed that light limitation is responsible for the disappearance of characeans during eutrophication. (Doria-PTT)
W89-06534

DISCRIMINATION OF FACTORS INFLUENCING BIOTA OF A STREAM RECEIVING MULTIPLE-SOURCE PERTURBATIONS,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
J. H. Van Hassel, D. S. Cherry, J. C. Hendricks, and W. L. Specht.
Environmental Pollution ENPOEK, Vol. 55, No. 4, p 271-287, 1988. 3 fig, 4 tab, 37 ref.

Descriptors: *Water pollution effects, *Powerplants, *Stream biota, *Oil wastes, *Mine wastes, *Toxicity, Blaine Creek, Kentucky, Aquatic life, Streams, Monitoring, Sampling, Benthos, Crustaceans, Regression analysis, Scouring, Rainfall, Sand.

Blaine Creek is a fifth-order stream located in eastern Kentucky that has been subject to contamination by oil brines, surface mining, and a coal fly ash settling pond discharge. Toxicity tests, effluent and receiving water chemical monitoring, and Blaine Creek benthic sampling were used to evaluate the effect of the ash pond effluent on the creek. Reproductive impairment of Ceriodaphnia was demonstrated at effluent concentrations ranging from 30 to 100%, but no instream impact on benthic invertebrates could be found at effluent flows that provided up to 65% of the creek's discharge. Correlation and regression analysis of physicochemical versus benthic monitoring data indicated that upstream oil brine contamination and scouring of the creek's predominantly shifting sand substrate during rainfall events were the primary factors affecting the benthic fauna, and appeared to override potential effects from other sources. These results demonstrated the value of integrated field/laboratory investigations for effluent impact assessments. (Author's abstract)
W89-06536

ANALYSIS OF OIL-OXIDIZING AND HETEROTROPHIC MICROFLORA OF THE COASTAL WATER OF THE EASTERN MURMAN, BARENTS SEA (ANALIZ NEFTEOKISLYAYUSHCHEI I GETEROTROFNOI MIKROFLORY PRIBREZHNYKH VOD VOSTOCHNOGO MURMANA),
Murmanskii Morskoi Biologicheskii Inst. (USSR).
Lab. of Microbiology.
S. G. Dermicheva.
Biologiia Moria BIMOD4, No. 3, p 32-36, 1985. 1 fig, 3 tab, 14 ref. English summary.

Descriptors: *Biodegradation, *Fate of pollutants, *Water pollution effects, *Coastal waters, *Barents Sea, *Oil pollution, *Microorganisms, Seasonal variation, Seawater, Pseudomonas, Self-purification, Bacteria.

The numbers of hydrocarbon-oxidizing microorganisms in the Barents Sea were found to depend on the level of sea water pollution by oil products during the spring. The numbers of microorganisms in sea water decreased with distance from the shore, i.e. from the source of pollution. The hydrocarbon-oxidizing microorganisms isolated from the coastal areas of the Barents Sea were identified as pseudomonas, pseudobacteria, and bacteria. Data obtained from both field investigations and culture

studies led to the conclusion that these hydrocarbon-oxidizing microorganisms play a substantial role in the self-purification of petroleum-polluted waters in the region studied. (Peters-PTT)
W89-06555

COMPOSITION AND DYNAMICS OF ZOOPLANKTON AND ZOOBENTHOS IN LAKE SARYKAMISH (SOSTAV I DINAMIKA ZOOPLANKTONA I ZOOBENTOSA OZERA SARYKAMYSH),
Akademiya Nauk Uzbekskoi SSR, Nukus. Inst. Estestvennykh Nauk.
S. Embergenov, L. P. Pavlovskaya, and N. Minazhev.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 3, p 24-30, 1987. 1 fig, 4 tab, 16 ref. English summary.

Descriptors: *Lake Sarykamish, *Zooplankton, *Eutrophication, *Water pollution effects, Organochlorine pesticides, Pesticides, Plankton, Seasonal variation, Biomass, Productivity.

Zooplankton (10 species) and zoobenthos (24 species) of Lake Sarykamysh (in Central Asia) belonging to the mesotrophic and eutrophic type were studied. The average amount of zooplankton (by season) varies from 12250 to 97000 specimens/cu m, its biomass from 730 to 9100 mg/cu m, and the average annual biomass is 5440 mg/cu m. The average quantity of zoobenthos varies from 1400 to 20170 specimens/sq m, its biomass varies from 9.33 to 83.30 g/sq m, and the average annual biomass is 39.8 g/sq m. The high biological productivity and intensification of the eutrophication processes are induced by the influx of biogenes. Residues of organochlorine pesticides entering the lake may also influence productivity. (Author's abstract)
W89-06558

METHOD TO DETERMINE WATER TOXICITY BY VARIATIONS IN THE GILL AREA OF FISH (METHODIKA OPREDELENIIA TOKSICHNOSTI VODNOI SREDY PO IZMENENIIAM ZHABERNOGO APPARATE RYB),
All-Union Research Inst. of Pond Fisheries, Rybnoe (USSR).
For primary bibliographic entry see Field 5A.
W89-06561

ROLE OF MEIOFAUNA IN THE BENTHOS COMMUNITIES IN VARIOUS LAKES IN LATGALIA (ROL' MEIOFAUNY V BENTOSNOM SOOBSHCHESTVE RAZNOTIPNYKH OZER LATGALII),
Akademiya Nauk SSSR, Leningrad. Inst. Ozerovedeniya.
E. A. Kurashov, and V. P. Belyakov.
Gidrobiologicheskii Zhurnal GBZUAM, Vol. 23, No. 2, p 46-50, 1987. 5 tab, 9 ref. English summary.

Descriptors: *Water pollution effects, *Benthos, *Lakes, *Latvia, *Eutrophication, Population dynamics, Fauna, Meiofauna, Zoobenthos.

Changes in the composition and quantitative development of the meiofauna have been studied in six lakes in the Latgalian hills in the Latvian SSR. The changes have been induced by anthropogenic eutrophication which results in a decrease of the meiobenthos fraction in the total biomass and in the quantity of zoobenthos. (Author's abstract)
W89-06567

BIOPRODUCTION ASPECTS OF AQUATIC TOXICOLOGY (BIOPRODUKTSIONNYE ASPEKTY VODNOI TOKSIKOLOGII),
Akademiya Nauk URSR, Kiev. Inst. Hidrobiologii.
L. P. Braginskii.
Gidrobiologicheski Zhurnal GBZUAM, Vol. 24, No. 3, p 74-83, 1988. 48 ref. English summary.

Descriptors: *Toxicology, *Hydrobiology, *Water pollution effects, *Plankton, Pesticides, Heavy metals, Phytoplankton, Productivity, Crustaceans, Primary productivity.

The relationships between hydrobiology and aquatic toxicology are considered. Basic results from experimental studies on the effects of pesticides, heavy metals and other toxicants on primary phytoplankton production and the productivity of the planktonic crustacean population are generalized. The development of toxicological hydroecology, a synthetic scientific trend which deals with studies of the effects of toxicants on the production-destruction processes in the aqueous environment is necessary. (Author's abstract)
W89-06572

DISTRIBUTION OF HEAVY OIL-DEGRADING BACTERIA IN THE OIL-POLLUTED AREAS CAUSED BY THE MIZUSHIMA OIL SPILL ACCIDENT (IN JAPANESE),
Shimonoseki Univ. of Fisheries (Japan). Lab. of Microbiology.
H. Fujisawa, M. Murakami, B. Kimura, and K. Ohtani.
Journal of Shimonoseki University of Fisheries, Vol. 36, No. 1, p 39-48, 1987. English Summary. 5 fig, 3 tab, 10 ref.

Descriptors: *Oil pollution, *Self-purification, *Bacteria, *Water pollution effects, *Seto Sea, Japan, Bottom sediments, Marine sediments, Seawater, Oil spills, Population density.

The distribution of heavy oil-degrading bacteria in oil-polluted areas of the Seto Inland Sea (Bisan Seto) caused by the Mizushima Oil Spill Accident was investigated for 1 yr, to assess bacteriological self-purification of the areas following this accident. Heavy oil-degrading bacteria (Groups A and B) in seawater and bottom sediment in the Seto Sea were enumerated using a membrane filter method and heavy oil of the same quality as that spilt in the accident. The population densities of heavy oil-degrading bacteria in seawater, Groups A and B, were 1 to 1,000 and 1 to 100/ml, respectively and the density of Group A was 10 times as much as that of group B. The density of Group A in seawater in the coastal areas near Mizushima and Sakaide was higher than that of the same group in the middle of the Seto Sea, but there was no remarkable difference in the density of Group B bacteria in seawater throughout the surveyed areas. The population densities of both Groups A and B in bottom sediments were 100-10,000/gm. It is concluded that various heavy oil-degrading bacteria contribute to decomposing the heavy oil spilled into the Seto Sea. (Author's abstract)
W89-06601

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME II.
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 2L.
W89-06605

ZOOPLANKTON DISTRIBUTION IN THREE ESTUARINE BAYOUS OF THE CALCASIEU RIVER/LAKE COMPLEX WITH DIFFERENT TYPES OF ANTHROPOGENIC INFLUENCE,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
M. Vecchione.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 202-236, 15 fig, 1 tab, 29 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Distribution patterns, *Bayous, *Louisiana, *Zooplankton, *Estuaries, *Calcasieu River, *Calcasieu Lake, *Water pollution effects, Agricultural pollutants, Municipal wastes, Oil wastes, Ecological effects, Synoptic analysis.

Zooplankton was sampled in three tributaries of the Calcasieu Estuary: one flowing through an area of petrochemical industries, one through a municipal area, and one through an agricultural area. Synoptic comparisons among the bayous were made on eight trips over a two-year period. Additionally, each bayou was sampled intensively for small-scale distribution on four occasions. Numbers of all zooplankton taxa were consistently higher in the agricultural bayou than in either of the other bayous. Patterns of small-scale spatial variability also differed among the bayous. The agricultural bayou appeared to be a relatively healthy estuarine tributary. The municipal bayou is severe in the vicinity of the municipal sewage and storm-drain outfalls. Evidence indicated that the industrial bayou suffered from frequent, but not continuous, episodes of environmental stress throughout its length. (See also W89-06605) (Author's abstract)
W89-06612

INTRODUCTION AND METHODS: BENTHOS,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 273-283, 1 fig, 1 tab, 15 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Estuaries, *Ecosystems, *Water pollution effects, *Benthos, Benthic environment, Water quality control, Bioindicators, Ecological distribution, Bottom sediments, Population density.

The distribution and abundance of macrobenthic organisms in the Calcasieu Estuary were examined in order to characterize benthic communities in various habitats of the area. The study was divided into several components concerning various aspects of the ecology of benthic species. The macrobenthos are those macroscopic benthic organisms that are retained on a 0.5 mm screen sieve following rinsing. Generally considered good indicators of pollution, they are especially important in assessing impacts of pollutants that remain on or over estuarine sediments. The primary objective of this study was to characterize macrobenthic communities of the Calcasieu Estuary in light of pollution effects. Several additional investigations of benthic communities became natural spinoffs of the primary study. Each of these investigations became a separate component of the overall benthic study. (See also W89-06605) (Lantz-PTT)
W89-06615

EFFECTS OF POLLUTANTS ON MACROBENTHIC COMMUNITIES IN THE UPPER CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
G. R. Gaston, and J. C. Young.
IN: Ecosystem Analysis of the Calcasieu River/Lake Complex (CALECO). Report No. DOE/EP/31111--1-Vol. 2, June 26, 1987. Final Report. p 373-389, 1 fig, 2 tab, 7 ref. DOE Grant DE-FG01-83EP31111.

Descriptors: *Water pollution effects, *Benthos, *Calcasieu River, *Calcasieu Lake, *Louisiana, *Ecological effects, Bayous, Wetlands, Heavy metals, Polychaetes, Species density, Physiological ecology.

Macrobenthic samples collected from three oligohaline bayous in the upper Calcasieu Estuary were used for comparisons of biological variables versus concentrations of the contaminants. There were significant negative correlations between faunal density and concentration of Cu, Pb, Cr, Cd, Hg, and Zn in Contraband Bayou samples collected in March 1984, though no significant relationship was found for samples collected at other times. Contraband Bayou macrobenthic assemblages were dominated by polychaete worms. A similar macrobenthic assemblage inhabited nearly Bayou d'Inde, though faunal densities there were generally below those of Contraband Bayou. Although no significant relationship existed between the macrobenthos and metals collected most months, there were significant negative correlations between benthos and some metals in April 1984 collections. Bayou Verdine was inhabited by a more diverse fauna, primarily polychaetes, than Contraband Bayou or Bayou d'Inde. No significant relationships were found between the fauna and metals of

Bayou Verdine. In general, the macrofaunal assemblages of the upper Calcasieu Estuary were characterized as dominated by deposit-feeding species, mostly surface-deposit feeders. Omnivores and carnivores were less important. The most abundant species of the area were early colonizers, perhaps indicative of continuous physiological stress to the fauna. (See also W89-06605) (Author's abstract)
W89-06618

NEKTON ASSEMBLAGES OF THE CALCASIEU RIVER/LAKE COMPLEX,
McNeese State Univ., Lake Charles, LA. Dept. of Biological and Environmental Sciences.
For primary bibliographic entry see Field 2L.
W89-06620

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME IV.
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 2L.
W89-06622

ANNUAL REPORT, 1985: NATIONAL ACID PRECIPITATION ASSESSMENT PROGRAM.
Interagency Task Force on Acid Precipitation, Washington, DC.
For primary bibliographic entry see Field 5B.
W89-06650

EFFECT OF CHLORINE POSITION ON THE DEGRADATION OF DICHLOROPHENOLS IN ANAEROBIC POND SEDIMENT,
Environmental Research Lab., Athens, GA.
J. E. Rogers, and D. D. Hale.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-134853. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/353, December 1987. 29p, 3 fig, 8 tab, 32 ref.

Descriptors: *Microbial degradation, *Molecular structure, *Path of pollutants, *Fate of pollutants, *Anaerobic conditions, *Ponds, *Bottom sediments, *Chlorine, *Dichlorophenol, Water pollution effects, Sediment contamination, Anaerobic ponds, Biodegradation, Degradation products.

To better understand the microbial degradation of chemicals in anaerobic environments, the degradation of chlorinated phenols was examined in freshwater sediments. The study demonstrated that the relative persistence of the dichlorophenols depended on the chemical structure of the individual isomers. The initial step in degradation was the reductive dechlorination of a single chlorine to form the monochlorophenol as an intermediate. Chlorine at the 2-position of dichlorophenols was the most readily reduced. The results show that caution should be used in extrapolating laboratory data to predict degradation rates at field sites. (Author's abstract)
W89-06663

RECOVERY OF CANADIAN LAKES FROM ACIDIFICATION,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
For primary bibliographic entry see Field 5G.
W89-06681

EXPOSURE OF SMALL-SCALE AQUATIC SYSTEMS TO VARIOUS DEPOSITION LEVELS OF AMMONIUM, SULPHATE AND ACID RAIN,
Katholieke Univ. Nijmegen (Netherlands). Lab. of Aquatic Ecology.
J. A. A. R. Schuurkes.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 34-45. 5 fig, 4 tab, 36 ref.

Descriptors: *Water pollution effects, *Ammonium, *Sulfates, *Acid rain effects, *Ecosystems, Greenhouses, Artificial precipitation, Sulfur, Nitrogen, Hydrogen ion concentration, Chemistry of precipitation, Revegetation, Rehabilitation.

In a greenhouse two experiments were conducted in which small-scale aquatic ecosystems were exposed to synthetic-rain solutions. Rain containing sulfuric acid and rain containing ammonium sulfate were used to create different deposition levels of acid, sulfur, and ammonium nitrogen. In the first experiment seven soft-water systems were exposed during a two-year period to rain differing in pH (5.6 to 3.5), ammonium (1.4 to 8.5 kmol/ha/year) and sulfate (0.1 to 4.4 kmol/ha/year). From the acidic sulfate treatments only the pH=3.5 treatment caused a decrease in pH (from 5.5 down to 4.2). Within the same period the pH=5.6 ammonium sulfate treatments caused a stronger acidification (down to pH 4.1-3.5). Dose/effect relations were established between deposition of acid, nitrogen, and sulfur on the one hand, and acidification, water quality, and vegetation on the other. In the second experiment two acid-water systems were exposed to N-polluted, S-polluted, and unpolluted rain. During the first year the unpolluted rain resulted in an increase in pH (from 4.6 to 6.4) and alkalinity (plus 50 microeq/l). A remarkable phenomenon in one of these systems was the appearance of Lobelia dortmanna, which had disappeared from its natural growing site after 1957. Reversibility of acidification in acid-stressed systems appeared to be possible under certain conditions. (See also W89-06680) (Author's abstract)
W89-06684

CHEMICAL AND BIOLOGICAL FEATURES OF POORLY BUFFERED IRISH LAKES,
Foras Forbartha, Dublin (Ireland).
For primary bibliographic entry see Field 2H.
W89-06685

ACIDIFICATION PROBLEMS OF FRESHWATERS: TROPHIC RELATIONSHIPS,
Freshwater Biological Association, Ambleside (England).
D. W. Sutcliffe, T. R. Carrick, A. C. Charmier, T. Gledhill, and J. G. Jones.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 64-66. Commission of the European Communities Contract ENV. 865.UK(H).

Descriptors: *Acid rain effects, *Acid water, *Water pollution effects, *Stream biota, *Food habits, *Animal physiology, Survival, Mortality, Cyanophyta, Chlorophyta, Chlorophyll a, Mosses, Diatoms, Stoneflies, Mayflies, England.

The foods and physiological requirements of selected herbivorous benthic invertebrates living in 'acid' waters (pH below 5.5) and in circumneutral 'soft' waters (pH 6.5-7.0), chiefly in streams of the River Duddon catchment in the English Lake District were examined. Survival with and without food was also examined in laboratory experiments. In upland acid streams of the River Duddon, the epilithon on stones consisted mainly of four filamentous algae; relative abundances of each varied between streams. These were thick-sheathed blue-green Cyanophyceae (Homeothrix caespitosa and Scytonema crispum) and green filamentous Chlorophyceae (Hormidium subtile and Zygogonium sp.). Algae were quantified by measuring chlorophyll a. A liverwort, Nardia compressa, predominates in acid streams whereas a moss, Hygrohypnum luridum, predominates in soft streams. Epiphytic diatoms, Eunotia and Peronia, are numerous in the leaf axils of Nardia, where they are relatively inaccessible to grazing animals. In acid streams the stonefly larva Amphinemura sulcicollis feeds on Nardus and Sphagnum leaves, and on the algae Hormidium, Zygogonium, and Tabellaria. At 10 C the mayflies Baetis muticus and B. rhodani survived (unfed) for only 2 to 8 days in acid streamwaters at pH 4.9 to 5.2. Survival of B. rhodani was better (100% survival after 8 days but 100% mortality after 11 days) in acid tarnwater at pH 4.8. (See also W89-06680) (Shidler-PTT)
W89-06686

PHYSIOLOGICAL STUDY ON THE RECOVERY OF RAINBOW TROUT (SALMO GAIRDNERI RICHARDSON) FROM ACID AND AL STRESS,
Antwerp Univ., Wilrijk (Belgium). Dept. of Biology.
H. E. Witters, J. H. D. Vangenechten, S. van Puymbroeck, and O. L. J. Vanderborght.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 67-75. 5 fig, 1 tab, 9 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Rehabilitation, *Fish physiology, *Acidity, *Aluminum, Calcium, Sodium, Acidic water, Stress, Mortality, Trout, Gills, Permeability.

It is known that the ionoregulatory system of fishes is seriously affected in acid soft waters with or without elevated aluminum concentrations. High branchial ion losses are supposed to result from calcium-modulated increases in the permeability of the branchial epithelium. The results of preliminary experiments on the recovery of rainbow trout after exposure to acid water (pH 5.0) or to acid water with Al (pH 5.0 + 100 microg Al/L) are presented. Recovery was studied at pH 6.9 with low (1.0 mg/L) and high (19.0 mg/L) Ca levels. Compared to acid stress alone, fish were more affected by the combined stress of acidity and Al (90% mortality, severe sodium ion and chloride whole-body loss). However, indications were obtained that the depleted plasma Na content increased faster to normal values after combined acid + Al stress. Indeed, fish exposed to acid without Al were not able to restore the normal plasma ion concentrations after 7 days of recovery. High Ca levels in the water did not favor recovery in these experiments. (See also W89-06680) (Author's abstract)
W89-06687

DEVELOPMENT OF THE ACID LAKE GRIBSO IN DENMARK AFTER 1950,
Copenhagen Univ., Hilleroed (Denmark). Det Ferskvands-Biologiske Lab.
For primary bibliographic entry see Field 2H.
W89-06688

CHEMISTRY OF ATMOSPHERIC DEPOSITION AND LAKE ACIDIFICATION IN NORTHERN ITALY, WITH EMPHASIS ON THE ROLE OF AMMONIA,
Istituto Italiano di Idrobiologia, Pallanza (Italy).
R. Mosello, A. Pugnetti, and G. A. Tartari.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 85-94. 3 fig, 5 tab, 28 ref.

Descriptors: *Industrial wastewater, *Water pollution effects, *Acidification, *Lakes, *Acidic water, *Chemistry of precipitation, *Ammonia, *Italy, Rainfall, Oxidation, Chemical wastes, Tributaries, Hydrogen ion concentration, Alkalinity, Acidic soils.

The only case of a strongly acidic lake in North Italy is Lake Orta, an important body of water located in the Lake Maggiore watershed. The acidification is caused by the oxidation of ammonia, which is discharged in large amounts into the lake by a rayon factory. Oxidation of this discharge has lowered the pH from original values above 6.0 to the present values of 3.8-4.3 throughout the water column at turnover. The importance of in-lake processes in causing acidification was confirmed by the fact that the water input from the tributaries is buffered, with a mean total alkalinity of about 0.3 meq/L and a pH generally above 7.0. The potential acidification capacity of ammonia must also be considered in the case of atmospheric deposition. The importance of ammonia among the ionic constituents of rainwater in northern Italy is underlined. Even if the fact that the ammonia is not necessarily all oxidized to nitrate is taken into account, the contribution to acidification of the ammonia transformation in the soil and/or in the lake water is still of great importance. (See also W89-06680) (Author's abstract)
W89-06689

EVIDENCE OF STREAM ACIDIFICATION IN DENMARK AS CAUSED BY ACID DEPOSITION,
Miljoestyrelsen, Silkeborg (Denmark). Freshwater Lab.

For primary bibliographic entry see Field 5B.
W89-06697

BIOCHEMICAL CHARACTERIZATION OF ESTUARINE BENTHIC MICROBIAL COMMUNITIES FOR USE IN ASSESSING POLLUTION IMPACTS,
Florida State Dept. of Environmental Regulation, Tallahassee.
S. J. Schropp, F. G. Lewis, W. Eubanks, K. R. Carman, and D. C. White.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 311-325, 5 fig, 9 tab, 33 ref. Florida Institute of Government STAR grant 85-029.

Descriptors: *Biomonitoring, *Estuarine environment, *Benthic microorganisms, *Water pollution effects, *Field tests, *Phospholipids, Sediments, Particle size, Metals, Principal component analysis, Florida, Correlation analysis, Gas chromatography, Bacteria, Eukaryotes, Biscayne Bay, Pensacola Bay.

Monitoring the benthic microbial community offers a means of assessing biological changes in response to pollutants at the base of the estuarine food web. Traditional methods of microbial community analysis are inadequate because they require removal of the microorganisms from their habitat for culture on laboratory media, resulting in bias. Biochemical techniques, however, allow the microbial community structure to be analyzed without removing the microorganisms from their habitat. Analyses of phospholipid fatty acids (PLFA) were employed to characterize benthic microbial community structure in Biscayne and Pensacola Bays, Florida, and to related changes in microbial community structure to sources of metal pollution. Sediment samples were obtained from clean and contaminated areas of each bay system. PLFA were analyzed by capillary gas chromatography after modified Bligh-Dyer extraction and silicic acid column chromatography. Principal components analysis was used to distinguish geographic areas, and stations within these areas, from one another based on either geochemical or microbial PLFA data. Canonical correlation was used to construct a linear relationship between metal concentrations and microbial PLFA characteristics, but was confounded by sediment grain size. Polluted stations were generally characterized by high metal concentrations, fine-grain sediments, high lipid phosphate, high trans/cis fatty acid ratios, high bacterial PLFA, and low eucaryotic PLFA. (See also W89-06705) (Author's abstract)
W89-06735

VARIABILITY OF THE ACUTE TOXICITY OF DRILLING FLUIDS TO MYSIDS (MYSIDOPSIS BAHIA),
Environmental Research Lab., Gulf Breeze, FL.
P. R. Parrish, and T. W. Duke.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 326-333, 4 tab, 15 ref.

Descriptors: *Water pollution effects, *Crustaceans, *Toxicity, *Bioassay, *Drilling fluids, Hydrocarbons, Comparison studies, Performance evaluation, Pollutant identification.

Numerous factors affect the acute toxicity of drilling fluids (muds) to mysids. These include: (1) the source, composition, and age of the drilling fluid sample; (2) preparation of the test material; (3) the condition of test animals; and (4) the skill of experience of the people conducting the tests can influence test results. Despite these confounding factors, the observed intralaboratory variation of median lethal concentrations (96-hr LC50s) for six tests with a laboratory-prepared generic drilling fluid was within a factor of two. The 96-hr LC50s in these tests were from 5.4 mg/L to 8.0 mg/L. Interlaboratory variation for seven commercial laboratories that tested the same generic drilling fluid was within a factor of four, the same as that reported in the literature for acute toxicity tests with single chemicals. Test results from the seven laboratories ranged from 1.1 mg/L to 15.8 mg/L using a laboratory-prepared drilling fluid with suspended particulate phase ranging from 0.45 to 7.4%. The presence of petroleum hydrocarbons in drilling fluids greatly increases toxicity and, because toxic, volatile fractions may be lost, the variability of results from tests with petroleum hydrocarbon-contaminated drilling fluids may be greater than that stated. (See also W89-06705) (Rochester-PTT)
W89-06736

TOXICITY TESTING OF DRILLING FLUIDS: ASSESSING LABORATORY PERFORMANCE AND VARIABILITY,
Environmental Protection Agency, Washington, DC. Office of Water Regulations and Standards.
For primary bibliographic entry see Field 5A.
W89-06737

ACUTE TOXICITY AND HYDROCARBON COMPOSITION OF A WATER-BASED DRILLING MUD CONTAINING DIESEL FUEL OR MINERAL OIL ADDITIVES,
Springborn Life Sciences, Inc., Wareham, MA.
R. J. Breteler, A. G. Requejo, and J. M. Neff.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 375-390, 9 fig, 5 tab, 7 ref. American Petroleum Institute Research Agreement 245 (Battelle Memorial Institute).

Descriptors: *Water pollution effects, *Macroinvertebrates, *Toxicity, *Bioassay, *Drilling fluids, Fuel, Hydrocarbons, Comparison studies, Crustaceans, Mollusks, Polychaetes, Performance evaluation.

A series of static and flow-through toxicity tests was conducted using four species of marine invertebrates to determine the toxicity of drilling mud containing three classes of hydrocarbon additives: low-sulfur diesel fuel, high-sulfur diesel fuel, or a commercial mineral oil additive. The hydrocarbon additives were characterized chemically by computerized gas chromatography/mass spectrometry. The base mud was a laboratory-formulated freshwater lignosulfonate mud (generic No. 8). Acute toxicity tests were performed with mysids (Mysidopsis bahia) by using the suspended particulate phase (SPP) of a 1:9 dilution of drilling mud with seawater. Ten-day solid phase (SP) toxicity tests were conducted with sand worms (Nereis virens), grass shrimp (Palaemonetes pugio), and soft-shell clams (Mya arenaria) by using mud solids that settled to the bottom of the mixing container during a 1-hr settling period. Exposure concentrations of total hydrocarbons, BOD, COD, and total organic carbon were confirmed analytically. Base mud without additives was practically nontoxic. Drilling mud that contained 5% mineral oil was less toxic than mud containing 55 of either low- or high-sulfur diesel fuel additive, with LC50 values of 3090, 451, and 276 mg/L, respectively. Drilling mud solids containing mineral oil were not acutely toxic to the test organisms, but lethality was observed when animals were exposed to the mud solids that contained 5% diesel fuel. (See also W89-06705) (Author's abstract)
W89-06738

TOXICITY OF U.S. WATERWAY SEDIMENTS WITH PARTICULAR REFERENCE TO THE NEW YORK HARBOR AREA,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
R. A. Jones, and G. F. Lee.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 403-417, 5 fig, 4 tab, 16 ref.

Descriptors: *New York Harbor, *Water pollution effects, *Estuarine sediments, *Navigable waters, *Crustaceans, *Toxicity, *Pollutants, Bioassay, Grass shrimp, Daphnia, Chlorinated hydrocarbons, Heavy metals, Ammonia, Mortality.

A study was conducted in the mid- to late-1970s on the toxicity of elutriate test mixtures of water and sediment from United States harbors and waterways to grass shrimp or Daphnia. For many waterways, 20-30% mortality was found after 96-hr exposure, but those of the New York harbor area showed somewhat greater toxicity. The specific cause of the mortalities was not investigated at that time. The sediments contained a wide variety of chemical contaminants that, if available to the organisms, could be toxic to them. More than 30 chemical parameters, including heavy metals and chlorinated hydrocarbon pesticides, were measured in the sediments; of the parameters measured, only ammonia was released in sufficient amounts to potentially cause acute lethality in the test waters associated with the sediments. Recent review of the data showed that there is a relationship between the concentration of ammonia in the sediment/water mixtures (elutriates) and the mortality of grass shrimp in the tests. Furthermore, the concentrations that appeared to cause about 50% mortality of the grass shrimp in the 96-hr exposure were about the level of 96-hr LC50 to grass shrimp for ammonia. (See also W89-06705) (Author's abstract)
W89-06740

TOXICITY TESTING OF DREDGED MATERIALS USING MULTIPLE-SPECIES MICROCOSMS,
Old Dominion Univ., Norfolk, VA. Applied Marine Research Lab.
For primary bibliographic entry see Field 5A.
W89-06741

BIOLOGICAL-CHEMICAL CHARACTERIZATION OF EFFLUENTS FOR THE EVALUATION OF THE POTENTIAL IMPACT OF THE AQUATIC ENVIRONMENT,
National Swedish Environment Protection Board, Solna. Emission and Product Control Lab.
For primary bibliographic entry see Field 5A.
W89-06781

SEDIMENT AND PHOSPHORUS LOAD TO STREAMFLOW FROM NATURAL AND DISTURBED WATERSHEDS IN NORTHEASTERN MINNESOTA,
Minnesota Univ., Minneapolis. Graduate School.
For primary bibliographic entry see Field 4C.
W89-06965

5D. Waste Treatment Processes

ROLE OF CHEMICAL CONCENTRATION AND SECOND CARBON SOURCES IN ACCLIMATION OF MICROBIAL COMMUNITIES FOR BIODEGRADATION,
Cornell Univ., Ithaca, NY. Lab. of Soil Microbiology.
B. A. Wiggins, and M. Alexander.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2803-2807, November 1988. 4 fig, 1 tab, 14 ref.

Descriptors: *Nutrient requirements, *Acclimatization, *Biodegradation, *Wastewater treatment, *Carbon, *Microbiological studies, Phenols, Wastewater, Degradation, Mineralization.

A study was conducted to determine the role of concentration of the test chemical, of a second organic compound, and of mutation in the acclimation period before the mineralization of organic compounds in sewage. The acclimation period for 2 ug/L 4-nitrophenol (PNP) increased from 6 to 12 days in the presence of 10 mg/L 2,4-dinitrophenol. In contrast, the time for acclimation for the degradation of 2 ug PNP/L was reduced when 10 or 100 mg/L phenol was added. Lower phenol levels increased the acclimation period to 8 days. The length of the acclimation period for PNP mineralization decreased as the initial concentration of PNP increased from 2 ug to 100 mg/L. The accli-

mation period for phenol mineralization was lengthened as the phenol concentration increased from 100 to 1,400 mg/L. The length of the acclimation period for PNP and phenol biodegradation was reproducible, but it varied among replicates for the biodegradation of other nitro-substituted compounds added to sewage or lake water, suggesting that a mutation was responsible for acclimation to these other compounds. The acclimation period may thus reflect the time required for the destruction of toxins, and it also may be affected by the concentration of the test compound or the presence of other substrates. (Author's abstract)
W89-05797

REMOVAL OF HUMIC ACID AND TOXIC ORGANIC COMPOUNDS BY IRON PRECIPITATION,
Occidental Chemical Corp., Grand Island, NY. Grand Island Technology Center.
W. Ying, J. J. Duffy, and M. E. Tucker.
Environmental Progress ENVPDI, Vol. 7, No. 4, p 262-269, November 1988. 4 fig, 8 tab, 19 ref.

Descriptors: *Toxicity, *Chemical precipitation, *Pretreatment, *Humic acids, *Organic compounds, *Wastewater treatment, *Iron, Polymers, Biodegradation, Carbon, Adsorption, Polychlorinated biphenyls, Pesticides, Halogenated pesticides, Isotherms, DDT, Leachates, Industrial wastewater.

An innovative waste pretreatment process incorporating ferric hydroxide precipitation was developed for complete and efficient treatment of chemical waste landfill leachates and industrial wastewaters containing recalcitrant or toxic organic chemicals. Concentration of many non-biodegradable contaminants, such as chlorendic acid, was significantly lowered after removal of all ferric hydroxide precipitates. Precipitation and then removal of ferric hydroxide flocs in pretreatment of leachate, by pH adjustment, aeration, and sedimentation, resulted in almost complete removal of humic acid. The presence of humic acid, even at a low concentration level of 30 mg/L, significantly enhanced the removal capacity of ferrous hydroxide and ferric hydroxide precipitates for PCBs and many organochlorine pesticides by a combined mechanism of complexation, adsorption, and coprecipitation. Effective pesticide removal was accomplished by iron precipitation; removal was even better from mixture than from single-component solutions. It is concluded that an integrated process combining iron precipitation, biodegradation, and carbon adsorption offers provides effective removal of recalcitrant compounds from leachates and wastewaters. (Author's abstract)
W89-05810

ROLE OF SATURATED AND UNSATURATED ZONE IN SOIL DISPOSAL OF SEPTIC TANK EFFLUENT,
Government of the Northwest Territories, Yellowknife. Municipal and Community Affairs.
For primary bibliographic entry see Field 5E.
W89-05829

AUSTIN BENEFITS FROM SLUDGE COMPOSTING PROGRAM,
Austin Water and Wastewater Utility, TX.
For primary bibliographic entry see Field 5E.
W89-05834

ALTERNATIVE BULKING AGENT FOR SLUDGE COMPOSTING,
Los Angeles County Sanitation Districts, Carson, CA.
J. Hay, H. Ahn, S. Chang, R. Caballero, and H. Kellogg.
Biocycle BCYCDK, Vol. 29, No. 10, p 46-51, November-December 1988. 8 fig, 5 tab, 3 ref.

Descriptors: *Bulking sludge, *California, *Sludge thickening, *Wastewater treatment, Regression analysis, Los Angeles, Sawdust, Straw, Windrow process, Odors, Performance evaluation.

The Los Angeles County wastewater treatment facility at Carson, California, can handle 500 wet tons of sludge cake per day on a 25-acre site. A study was conducted to test side-by-side a bedding straw-sludge windrow versus a sawdust-sludge windrow; inactivation of indicators and pathogens in the two treatments is reported. Both windrows effectively inactivated bacterial indicators and pathogens. A least squares regression fit of data to the power function gave the best correlation between coliform density and cycle day. The straw windrow decreased in volume more than the sawdust windrow. It was estimated that, in full-scale operation, the productivity of straw windrows would exceed the productivity of sawdust windrows by more than 25%. Final compost products were well-stabilized, with humus-like texture and uniform particle size, and contained no objectionable odors. The emission of obnoxious odors was the major drawback of straw windrow composting. When used in an in-vessel application, bedding straw may be a very competitive alternative to sawdust. (Rochester-PTT)
W89-05835

WASTEWATER RECYCLING AND WATER CONSERVATION IN COMMERCIAL AND PUBLIC FACILITIES: CASE HISTORIES,
E. Clerico, and J. Irwin.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21, No. 6, p 10-14, November-December 1988. 4 tab.

Descriptors: *Water reuse, *Wastewater management, *Recycling, *Waste recovery, *Water supply, *Water conservation, Wastewater disposal, Case studies, Alternative water use, Sewer systems.

The increasing frequency of sewer bans, water supply limits, and sites not served by public sewer, has created a need for alternative water use and wastewater management practices which can satisfy development needs, while providing protection of the environment. A solution which addresses both the water supply and wastewater management issues is the use of wastewater recycling. In commercial and public facilities, on-site wastewater treatment and recycling for use as flush water in toilets has resulted in water use and wastewater discharge reductions of 95%. Recycling has been incorporated in numerous facilities in the U.S. to enable development to occur in a positive manner with a negligible impact. Two facilities with wastewater recycling are examined from a historical perspective, showing the decisions that resulted in choice of this process from a variety of alternatives. (Brock-PTT)
W89-05867

IMPROVING GRAVITY SLUDGE THICKENER PERFORMANCE: A CASE STUDY,
D. Garvey.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 21, No. 6, p 15-21, November-December 1988. 2 fig, 4 tab.

Descriptors: *Sludge thickening, *Wastewater treatment, *Wastewater facilities, *Sludge, Solid wastes, Gravity sludge thickeners, New York, Case studies, Sludge solids, Pumping, Primary sludge, Activated sludge, Sludge drying, Incineration.

A number of sludges from the New Rochelle and Mamaroneck, N.Y. Wastewater Treatment Plants have been analyzed. The solids concentration of sludge withdrawn from gravity thickeners at present is 5-6%. Combined New Rochelle and Mamaroneck sludges currently processed at the works could be thickened to 9% total solids and sludges expected in the future could be thickened to a total solids concentration of between 8 and 11%. The existing gravity thickeners are of suitable dimensions to achieve these improved results. Modifications to the existing raking mechanism and a new pumping control scheme will be required. Upgrading and addition of some peripheral equipment is recommended including a splitting box, potassium permanganate dosing equipment, and thickened-sludge storage facilities. Primary sludges produced at the works are generally quite unstable. Primary and activated sludges should be mixed prior to thickening to improve stability and optimize the solids concentration achieved. Modifications to the existing thickeners will reduce sludge volumes by up to 50% more than that achieved by current operation. This will result in significant savings on downstream processing such as pumping, dewatering and incineration. (Author's abstract)
W89-05868

REDUCING WASTEWATER TOXICITY,
AWARE, Inc., Nashville, TN.
P. W. Lankford, W. W. Eckenfelder, and K. D. Torrens.
Chemical Engineering (New York) CHEEA3, Vol. 95, No. 16, p 72-82, November 7, 1988. 5 fig, 10 tab, 16 ref.

Descriptors: *Water quality control, *Chemical wastewater, *Toxicity, *Wastewater treatment, Biological wastewater treatment, Bioassay, Metals, Organic compounds, Coagulation, Precipitation, Ion exchange, Reverse osmosis, Oxidation, Wet oxidation process, Stripping, Activated carbon, Filtration.

Chemical process industry plants are having to pay more attention to reducing the toxicity of the plants' wastewater discharges, by eliminating the discharge of toxic substances or by making the discharges less harmful. The standard technique for determining the toxicity of wastewater is the bioassay: the chronic bioassay and the acute bioassay techniques measure the long-term and short-term effects, respectively. Fractionation investigations determine the cause of effluent toxicity. The actual affluent is fractionated using chemical and/or physical means, or a sample that simulates the known toxic effect is synthesized. The procedure generally involves treating a sample to remove toxicity associated with specific chemical groups. Results of toxicity tests on the treated samples are compared with tests on the untreated effluent. Any difference indicates that the constituent(s) is likely to be responsible for the toxicity. To identify exactly where in a wastewater collection system the toxicity originates, a source analysis and sorting is performed. If the toxic component of a wastestream from a particular processing unit can be identified, process modification at that unit should be evaluated as the preferred, and most cost-effective, solution. This might include substitution of raw materials, or modification of reaction conditions to precipitate the component. The next effort should consist of locating the stream(s) containing a toxicant, even if the actual compound cannot be identified. One can then determine potential treatment technologies for reducing or eliminating this toxicity. Toxic metals can be removed by various precipitation, coagulation, ion-exchange, or reverse osmosis techniques. Most toxic organics can be removed in an aerobic biological system through one of three mechanisms: sorption, stripping, or biodegradation. If biological treatment is not sufficient to reduce the toxicity, it is necessary to add physical or chemical treatment. These technologies include activated carbon adsorption, chemical oxidation, wet air oxidation, macroporous-resin adsorption, stripping, and filtration. (Sand-PTT)
W89-05917

FLUIDIZED-BED BIOREACTORS,
Idaho National Engineering Lab., Idaho Falls. Biotechnology Unit.
G. Andrews.
Biotechnology and Genetic Engineering Reviews BGERES, Vol. 6, p 151-178, September 1988. 5 fig, 1 tab, 80 ref.

Descriptors: *Bioreactors, *Fluidized-bed reactors, *Wastewater treatment, *Biological wastewater treatment, Capital costs, Operating costs, Design criteria, Aeration, Chemical engineering.

Large-scale biochemical processes, e.g. wastewater treatment or fermentation, involve three main costs: the capital cost of the bioreactor and associated equipment, the cost of the substrates, and the costs associated with separating and purifying the product. The objective of the biochemical engineer

in designing and operating a bioreactor is to minimize the total costs, and this usually requires compromise between the three different costs. It is the need for these compromises that makes correct bioreactor design so important and that has motivated the development of the fluidized-bed bioreactor. This review explains this development in terms of the advantages of the fluidized bed over other types of reactors. Emphasis is placed on correct reactor design which reduces to choosing the shape of the reactor, the method of aeration and the type, size, density and size distribution of the particles in the bed. (Author's abstract)
W89-05922

INCREASING THE EFFECTIVENESS OF A LATRINES PROGRAMME,
National Improved Latrines Programme, Maputo (Mozambique).
M. Muller.
World Health Forum WHFODN, Vol. 9, No. 3, p 345-351, 1988. 12 tab.

Descriptors: *Public Health, *Sanitation, *Community development, *Developing countries, *Parasites, *Mozambique, Latrines, Ascaris, Surveys.

As Mozambique's Improved Latrines Programme grows, careful analysis of its operations is necessary to ensure that the intended benefits are being achieved. Surveys conducted by people directly involved in the Programme have produced useful information and helped to define priorities for future action. Considered in these surveys were: types of sanitation system used; knowledge of the Programme; sources of information; attitudes towards the improved latrine; latrine use and maintenance; children's use of latrines. The sanitary impact of the latrines was assessed by means of parasitological (Ascaris lumbricoides) indicators of fecal contamination of the environment. These surveys have also contributed towards strengthening links between the health authorities and the manufacturers and distributors of latrines and their components. (Author's abstract)
W89-05923

LOW-COST SANITATION FOR A SQUATTER COMMUNITY,
A. Hasan.
World Health Forum WHFODN, Vol. 9, No. 3, p 361-364, 1988.

Descriptors: *Public health, *Sanitation, *Pakistan, *Community development, *Sewer systems.

There are two major impediments to providing a sanitation system for a squatter colony: (1) local authorities do not have the finances for constructing a sewerage system; (2) the cost of urban services developed by local authorities is five times the actual cost of labor and materials; squatters cannot afford to pay the resulting charges. The Orangi Pilot Project in Karachi, Pakistan started in 1980 as a low-cost sanitation program aimed at finding alternative sources of finance and a new method of implementation that would not cost more than the materials and labor. Three concepts were central to the program: community participation; modification of standard engineering technology and implementation procedures to make them suitable for such participation; and redefinition of relations between the community and local government. As a result of this program, a major environmental and social change has taken place in Orangi. The sewerage systems are now clean and healthier, the people have undertaken to improve their houses, the value of their property has gone up, and the project is carrying out a housing program, a women's welfare program, and a program for women's work centers. The Orangi Pilot Project has shown that the condition of the poor can be improved through a development strategy in which the people participate, provide finance and take over some of the functions of government agencies. (Sand-PTT)
W89-05925

BIODEGRADATION OF OZONATED ATRAZINE AS A WASTEWATER DISPOSAL SYSTEM,
Agricultural Research Service, Beltsville, MD. Pesticide Degradation Lab.
For primary bibliographic entry see Field 5E.
W89-05947

DECHLORINATING WASTEWATER NEXT TO FISHERMAN'S WHARF,
General Chemical Corp., Claymont, DE. Delaware Development Lab.
S. L. Bean.
Water Engineering and Management WENMD2, Vol. 135, No. 11, p 36-37, November 1988.

Descriptors: *Wastewater treatment, *San Francisco, *Sodium sulfate, *Chlorination, *Sulfur dioxide, Sodium bisulfate, Dechlorination.

San Francisco's was the first major wastewater treatment system to dechlorinate with sodium bisulfite. The California city now uses sodium bisulfite at two of its three treatment facilities: (1) the Southeast Water Pollution Control Plant, and (2) the North Point Plant. An aqueous solution of sodium bisulfite is simply stored at atmospheric pressure and pumped to the point of injection. A magnetometer measures the flow. the city has saved significant capital in converting to this chemical. In use, sodium bisulfite has cut energy requirements and maintenance significantly. The only precaution needed with sodium bisulfite is to take steps to avoid crystallization in tanks and lines when the temperature falls below 50 F. This can be done either by diluting the normal 36% to 38% solution to about 32% before storing. In addition to its other advantages, this chemical provides peace of mind and offers the safest option for dechlorination in this densely populated area. (Miller-PTT)
W89-05955

STUDIES ON THE MECHANISM OF PHOSPHORUS REMOVAL FROM TREATED WASTEWATER BY SAND,
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Environmental Engineering.
D. B. Aulenback, and N. Meisheng.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2089-2094, December 1988. 3 fig, 7 tab, 11 ref.

Descriptors: *Wastewater disposal, *Land treatment, *Wastewater treatment, *Infiltration, *Secondary wastewater, *Phosphorus removal, Sand, Adsorption, Calcium carbonate, X-ray diffraction, Physicochemical treatment, Wastewater.

Studies to identify the mechanism of phosphorus removal from secondary treated wastewater in a rapid infiltration land application system consisting of delta sand were undertaken. Column studies conducted under normal biotic and abiotic (sterile) conditions confirmed previous conclusions that phosphorus removal is primarily a physical-chemical process rather than a biological one. Adsorption, as measured in shaker studies, did not account for all of the measured phosphorus removal by the sand particles. Sand from a sewage treatment plant rapid infiltration system, that had a coating primarily of precipitated CaCO3, was studied. Removal of this coating nearly eliminated phosphorus removal and its presence or absence play an important part in the phosphorus removal mechanism. X-ray diffraction studies showed the presence of CaCO3, CaHPO4, CAH2P2O7, and AlPO4 in the coating on the sand. (Author's abstract)
W89-05972

DEVELOPMENT OF SETTLING FLUX CURVES USING SVI,
Clemson Univ., SC. Dept. of Environmental Systems Engineering.
E. J. Wahlberg, and T. M. Keinath.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2095-2100, December 1988. 5 fig, 2 tab, 21 ref.

Descriptors: *Secondary wastewater treatment, *Activated sludge, *Wastewater treatment *Clarifiers, *Sedimentation, *Sludge volume index, Settling, Mathematical studies, Flux, Velocity.

A relationship is developed between sludge volume index (SVI) and the two settling parameters which describe activated sludge interface settling velocity as a function of suspended solids concentration. An equation is given which allows the development of a settling flux curve from a single activated sludge settling test. The developed relationship is based on experimental settling flux and sludge volume index data collected at 21 full-scale activated sludge plants. Sludge volume indexes were measured by four different commonly used methods: SVIGS and SVIGN, performed in a graduated cylinder with and without slow speed stirring; SVISS and SVISN, performed in a settlometer, with and without slow speed stirring. The plants tested varied considerably in size, geographic location, mode of operation, method of aeration, and type and amount of industrial input. Based on the results obtained from an extensive field study of 21 full-scale activated sludge plants, the following conclusions can be drawn: a single mathematical formulation relating SVI to settling velocity for the different SVIs studied could not be developed because of the different functional relationships shown to exist between the Vesilind settling parameters and the different SVIs; the preferred technique for determining the SVI to be used for predicting settling flux uses a stirred 1-L graduated cylinder; the empirical model developed for predicting settling flux is suitable for developing settling flux curves to be used for state point control. (Author's abstract)
W89-05973

MEAN CELL RESIDENCE TIME AND SLUDGE YIELD CALCULATIONS VIA PHOSPHORUS BALANCE,
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.
M. Reddy, B. Kopman, S. Keely, B. Hale, and R. Reardon.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2101-2104, December 1988. 6 fig, 4 ref.

Descriptors: *Sludge, *Activated sludge, *Phosphorus, *Wastewater treatment, *Mean cell residence time, Mass balance calculations, Yield.

Equations were derived for calculating mean cell residence time and sludge yield from mass balances on phosphorus in the activated sludge process. This approach does not require estimation of sludge production quantities and thus is independent of waste activated sludge measurements. Based on data from two pilot-scale systems and one full-scale plant, it was found that mean cell residence time and sludge yield calculated by the phosphorus balance approach corresponded closely to values of these parameters calculated from mass balances on total suspended solids. Nomograms for rapid graphical determination of mean cell residence time and sludge yield from phosphorus data are presented. (Author's abstract)
W89-05974

INFLUENCE OF SIMULATED RAINFALL ON THE TRANSPORT AND SURVIVAL OF SELECTED INDICATOR ORGANISMS IN SLUDGE-AMENDED SOILS,
Engineering Science, Fairfax, VA.
For primary bibliographic entry see Field 5B.
W89-05975

VARIABLES INFLUENCING SULFIDE CONCENTRATION IN A GRAVITY FLOW COLLECTION SYSTEM,
Sybron Chemicals, Inc., Salem, VA.
W. T. Stringfellow, N. R. Connell, C. F. Felin, and W. P. Coleman.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2111-2114, December 1988. 1 tab, 2 ref.

Descriptors: *Dissolved oxygen, *Flow, *Sulfides, *Organic carbon, *Wastewater treatment, Mathe-

matical studies, Temperature effect, Hydrogen ion concentration, Regression analysis.

Simple linear regression analysis was used to measure the relationship between pH, air temperature, precipitation, total organic carbon concentration, dissolved oxygen concentration, and wastewater flow and to determine their relative importance to sulfide production. Sulfide concentration was significantly correlated to dissolved oxygen concentration, total organic carbon concentration, air temperature, and wastewater flow. All relationships with sulfide (and among the variables) were positive and approximately linear. The one exception was that dissolved oxygen concentration exhibited a negative, nonlinear correlation with sulfide and the other variables. Flow and air temperature were highly correlated; therefore, the effects of these two variables could not be differentiated. The correlation of flow with dissolved oxygen concentration, total organic carbon concentration, and temperature explains the positive relationship between wastewater flow and sulfide concentration. (Author's abstract)
W89-05976

NUTRIENTS REMOVAL AND CONSERVATION BY ACTIVATED ALGAE IN AN OXIDATION DITCH,
Indian School of Mines, Dhanbad.
S. K. Maiti, S. K. Gupta, and S. G. Joshi.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2115-2119, December 1988. 3 fig, 4 tab, 11 ref.

Descriptors: *Chemical oxygen demand, *Wastewater treatment, *Algae, *Kinetics, *Nitrogen, *Nutrients, *Nutrient removal, *Phosphorus, *Oxidation ditches, Oxidation, Absorption, Bacteria, Organic compounds, Wastewater, Nutrients, Symbiosis.

The uptake of nitrogen and phosphorus by activated algae in an oxidation ditch was studied at solids retention times of 6 to 23 days. Removal of chemical oxidation demand reached 96% and removal of both nutrients was 67 to 96%. The kinetic data showed a system rate constant of 29.6 mg/L and a substrate utilization constant of 2.2 per days. The activated algae process was successfully used to demonstrate the removal and conservation of organics and nutrients from synthetic sewage. A distinct symbiotic relationship between algae and bacteria exists. (Miller-PTT)
W89-05977

LOW-ACTIVITY-LEVEL PROCESS WASTEWATERS: TREATMENT BY CHEMICAL PRECIPITATION AND ION EXCHANGE,
Oak Ridge National Lab., TN. Chemical Technology Div.
S. M. Robinson, J. M. Begovich, and C. B. Scott.
Journal - Water Pollution Control Federation JWPFA5, Vol. 60, No. 10, p 2120-2127, December 1988. 11 fig, 5 tab, 10 ref. Department of Energy Contract DE-AC05-84OR21400.

Descriptors: *Radioactive waste disposal, *Wastewater treatment, *Ion exchange, *Chemical precipitation, *Radioactivity, *Radioactive wastes, Wastewater, Strontium radioisotopes, Cesium radioscotopes, Decontamination.

Potential improvements to chemical precipitation and ion-exchange wastewater treatment methods is intended to reduce low-level radioactive waste generation were studied. The results of laboratory pilot and full scale screening tests are reported; these include the more promising process flowsheets, relative operating costs, and plant scale waste generation estimates. Results show that selected improvements made at the Oak Ridge National Laboratory treatment facility for decontamination of slightly radioactive process wastewater have reduced the liquid waste volume by 66%. The total waste generation (liquid and solid) has been reduced by 33%. Other processing improvements could lead to even further waste reductions. Results to data indicate that the chabazile zeolite system will be most economical for treating process wastewater slightly contaminated with Cs and Sr. (Author's abstract)
W89-05978

RECTANGULAR SHAFT CONFIGURATION FOR STORM SEWAGE OVERFLOW STRUCTURES,
Liverpool Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8A.
W89-05997

INLAND MARSHES ARE SAVING DOLLARS,
AJT Birmingham Engineers, Inc., Washington, DC.
T. H. Birmingham.
Public Works PUWOAH, Vol. 119, No. 12, p 50-52, November 1988. 2 fig, 1 tab, 9 ref.

Descriptors: *Biological wastewater treatment, *Cost analysis, *Wastewater treatment, *Marshes, *Artificial wetlands, Maryland, Wastewater facilities, Heat transfer, Anaerobic digestion, Bacteria, Ozonation, Potomac River, Sludge digestion, Disinfection.

A project to use artifical wetlands inland to convert and expand an existing wastewater treatment plant to 8.5 times its present capacity is described. The project, located in Ravens Creek (Maryland) will do so at a nominal cost and without interruption of service. Including the artificial wetlands, there are four major innovations. (1) The plasma bed reactor, a patented device that transfers heat to incoming wastewater, enables the first plant treatment chamber to prepare the incoming sewage to work within the thermophilic range of 120 to 140 F. (2) A flexible amorphous photovoltaic mat covers the first anaerobic lagoon and provides direct energy to heat the cell and thereby produce bioags. (3) The interior bacteria cluster is an insulated breeding ground for the bacteria types used in the process. (4) To complete the process, ozone gas is produced by the plasma bed reactor for disinfection of the effluent being discharged to the Potomac River. Flow is directed from the second anaerobic lagoon to a lined 12-acre artificial marsh, where it travels the full length of the marsh on a 0.1 percent slope before being pumped back to the marsh inlet. The plasma bed reactor, flexible amorphous photovoltaic mat, and interior bacteria cluster work well together to give the anaerobic process a new-found superiority; they also facilitate the action of the artificial wetland to totally purify wastewater by digesting most of the sludge rather than passing it onto the marsh. The unique advantages of these integrated systems should demonstrate applications at other locations. (Miller-PTT)
W89-06008

REMOVAL OF HEAVY METALS FROM SEDIMENTS BY MANGROVES IN JIULONG ESTUARY, XIAMEN HARBOUR, CHINA,
Xiamen Univ. (China). Inst. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-06019

STUDY ON THE SEASONAL VARIATION OF SURFACE SEDIMENT COMPOSITION IN ESTUARIES,
Okayama Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W89-06027

EFFECT OF MEDIA DESIGN ON THE PERFORMANCE OF COTTON FABRIC DESIZING AND SCOURING WASTEWATER TREATMENT IN UPFLOW ANAEROBIC FILTERS,
Patras Univ. (Greece). Dept. of Chemistry.
N. Athanasopolos, and T. Karadimitris.
Resources, Conservation and Recycling, Vol. 1, No. 2, p 123-129, June 1988. 2 fig, 6 tab, 7 ref.

Descriptors: *Wastewater treatment, *Filters, *Textile mill wastes, *Anaerobic conditions, Comparison studies, Aerobic conditions, Chemical oxygen demand, Industrial wastewater.

A two phase study was carried out to design a full-scale anaerobic filter for removal of chemical oxygen demand (COD) from cotton fabric desizing and scouring wastewater. During phase 1, two large laboratory scale reactors were packed with pieces of PVC tubing and modular corrugated cross-flow media while during phase 2 the same reactors were packed with pall rings and modular corrugated cross-flow media with the same design configuration but lower specific surface area than in phase 1. Results showed that the modular plastic media with cross-flow design had a better performance than pall rings and pieces of PVC tubing. Specific surface area of the modular media did not significantly effect the performance of the reactor. It was concluded that loose-fill media could not be used in a full-scale anaerobic filter. The selection of the appropriate cross flow media should be based on their resistance to plugging. Media with larger size of opening or smaller specific surface area should be selected, although their short term performance is a little worse than media of higher specific surface area. Using the modular corrugated cross-flow media of 98 sq m/cu m specific surface area and applying a load of 3 kg COD/cu m d the removal of COD, the biogas production and the methane content of biogas was 73%, 0.3 L/g COD and 75%, respectively. Cotton fabric finishing plants will realize conservation in neutralizing acid, nutrients, sludge treatment costs and energy for aeration. They can also recover energy as biogas due to the high temperature of wastewater. (Geiger-PTT)
W89-06179

SIMULTANEOUS SULFIDE AND ACETATE OXIDATION IN A DENITRIFYING FLUIDIZED BED REACTOR I: START-UP AND REACTOR PERFORMANCE,
Technische Hogeschool Delft (Netherlands). Dept. of Microbiology and Enzymology.
P. J. F. Gommers, W. Bijleveld, and J. G. Kuenen.
Water Research WATRAG, Vol. 22, No. 9, p 1075-1083, September 1988. 8 fig, 1 tab, 29 ref.

Descriptors: *Biological wastewater treatment, *Wastewater treatment, *Denitrification, *Fluidized bed process, *Oxidation, Performance evaluation, Sulfides, Nitrates, Carbon dioxide, Biomass, Model studies, Sulfur.

Part of the post-treatment of an anaerobic wastewater treatment plant described in a recent patent (EPA 0051.888) is a denitrifying fluidized bed reactor in which sulfide and lower fatty acids are removed. In this reactor the sand particles covered with biomass were kept in a fluidized state by the upflowing wastewater. A more detailed insight into the performance and resilience of the reactor under different operating conditions was required to assess the applicability of this type of reactor for a variety of wastewaters. A laboratory model of this denitrifying, fluidized bed reactor was built to show that sulfide and acetate could be removed from a synthetic wastewater using nitrate as the electron acceptor, and that the laboratory reactor could be used for further study of the mechanisms and performance of the pilot plant reactor. As an initial step, the start-up and overall performance were studied. Sulfide (2-3 kg S/cu m/d), acetate (4-6 kg C/cu m/d) and nitrate (5 kg N/cu m/d) were effectively removed. Only after the removal of oxygen from the influent with a pre-treatment column did the occurrence of elemental sulfur as an intermediate of the sulfide oxidation no longer lead to the build up of high sulfur concentrations in the reactor (only 0.3% of the sulfide added was converted to sulfur as long as nitrate was supplied in excess). Bacterial colonization of the sand particles and biomass growth was rapid in the first 4 days despite the high flow (dilution) rates applied. From the redox balances, it was concluded that biomass production increased with increasing loading rates. Plotting data from the individual days suggested that an average loading rate of 20-40 mequiv electrons/L reactor/hr would result in roughly no net growth. The redox balances show that net CO2 fixation may take place when sulfide plus sulfur turnover rates are high relative to those of acetate. The ratios of sulfide plus sulfur to acetate turnover rates above which

CO2 fixation started agreed well with data from chemostat studies of the facultative autotroph, Thiobacillus versutus. (See also W89-06182) (Author's abstract)
W89-06181

SIMULTANEOUS SULFIDE AND ACETATE OXIDATION IN A DENITRIFYING FLUIDIZED BED REACTOR: II. MEASUREMENTS OF ACTIVITIES AND CONVERSION,
Technische Hogeschool Delft (Netherlands). Dept. of Microbiology and Enzymology.
P. J. F. Gommers, W. Bijleveld, F. J. M. Zuijderwijk, and J. G. Kuenen.
Water Research WATRAG, Vol. 22, No. 9, p 1085-1092, September 1988. 9 fig, 3 tab, 21 ref.

Descriptors: *Biological wastewater treatment, *Fluidized bed process, *Biomass, *Wastewater treatment, *Suspended solids, *Oxidation, Nitrates, Sulfur, Sulfates, Nitrites, Sulfides.

An experimental set-up for the measurement of the biological activity of intact, fragile biomass particles in the presence of volatile substrates was used for the study of biomass taken from a fluidized bed denitrification reactor in which both acetate and sulfide were oxidized. The biomass in this reactor consists of a thick (1-2 mm), fragile layer of biomass that develops on the suspended sand particles (0.5 mm). Conversion rates calculated from the activity measurements were in good agreement with concentration profiles observed in the fluidized bed reactor. The oxidation of elemental sulfur, an intermediate of the sulfide oxidation, to sulfate was the rate limiting step in both the activity measurements and the reactor. Short-term pulses of acetate and sulfide to the fluidized bed reactor confirmed the overcapacity for sulfide to sulfur and acetate oxidation. Omitting sulfide or acetate during an activity experiment did not result in different behavior. Experiments in which nitrate depletion occurred showed that elemental sulfur could be used both as electron donor (oxidation to sulfate) and as electron acceptor (reduction to sulfide), while another electron donor in the particles, probably an organic polymer, remains to be identified. Activity measurements with nitrite as an electron acceptor showed an increased sulfur formation and nitrite concentrations in the reactor should therefore be kept as low as possible to ensure optimal performance of the system. Thiosulfate could readily be oxidized while propionate, although oxidized without a lag-period, led to the formation of nitrite. The versatility of conversions performed by the biomass represents either a large diversity of microorganisms or a relatively small group of very versatile organisms. Thiosphaera pantotropha, an organism isolated from the pilot plant version of this system, is an example of the latter group and further studies on the microbial composition may reveal more organisms of this type. (See also W89-18001)
W89-06182

MATHEMATICAL MODELLING OF TRANSIENT BEHAVIOUR OF DEEP BED FILTRATION,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran, and R. K. Tulachan.
Water Research WATRAG, Vol. 22, No. 9, p 1093-1100, September 1988. 2 fig, 2 tab, 14 ref.

Descriptors: *Model studies, *Water treatment, *Mathematical models, *Filtration, *Wastewater treatment, *Adsorption, Filters, Particle shape, Porosity, Particle size.

A mathematical model is proposed based on the concept that there exists a maximum limit on particle deposition on the filter grain to describe the entire cycle of filtration in a deep bed. Three coefficients of the mathematical model were calculated for different operating conditions using experimental results obtained from a filter 2 cm in depth. Although these model coefficients were different for different operating conditions, a uniform trend was observed in the variation of model parameters with operating conditions. The model consists of many parameters which have to be estimated from the fitting of the experimental concentration and headloss profiles with theoretical ones. If an empirical relationship between the model parameters and operating parameters is established from a limited number of laboratory-scale experiments, one can then simulate the filter performance for any other operating conditions of the given system. This feature should be useful in the rational design of a filter. (Geiger-PTT)
W89-06183

TOXIC RESPONSE OF NITROSOMONAS EUROPAEA TO COPPER IN INORGANIC MEDIUM AND WASTEWATER,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
C. Sato, S. W. Leung, and J. L. Schnoor.
Water Research WATRAG, Vol. 22, No. 9, p 1117-1127, September 1988. 9 fig, 8 tab, 50 ref, append. Iowa State Water Resources Research Institute Grant No. A-071IA.

Descriptors: *Nitrification, *Ammonia, *Copper, *Toxicity, *Biological wastewater treatment, *Wastewater treatment, Models, Bacteria, Activated sludge process, Domestic wastes, Oxidation.

A study was conducted to examine potential toxicity of copper(II) and its species in nitrification processes monitoring the oxidation of ammonia by Nitrosomonas europaea. The copper toxicity data were analyzed in terms of chemical speciation computed by a chemical equilibrium model. Increased toxicity with increasing ammonia concentration was observed for both the inorganic medium and the wastewater, that is analogous to the result reported for a full-scale nitrifying activated sludge plant. The 50% inhibition concentration (IC50) of total copper(II) decreased from 0.5 to 0.01 mg/L Cu(II) as the total ammonia concentration was raised from 3 to 23 mg/L as N. On the basis of statistical correlation, the increasing copper toxicity with increasing ammonia is apparent, which is further explained by the formation of copper-ammine complexes. The toxic response of N. europaea observed in the inorganic medium was defined as a function of the logarithmic activities of copper-ammine complexes. (Author's abstract)
W89-06186

EVALUATION OF A CHLORAMINE DECOMPOSITION MODEL INCORPORATING GENERAL ACID CATALYSIS,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 5F.
W89-06190

LOW TEMPERATURE NITROGEN REMOVAL IN SEQUENCING BATCH REACTORS,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
J. A. Oleszkiewicz, and S. A. Berquist.
Water Research WATRAG, Vol. 22, No. 9, p 1163-1171, September 1988. 7 fig, 3 tab, 20 ref, append.

Descriptors: *Biological wastewater treatment, *Cold regions, *Nitrogen removal, *Denitrification, *Wastewater treatment, Nitrification, Temperature effects, Activated sludge process, Industrial wastes, Pharmaceutical wastes, Retention time.

A study of the upgrading and modification of the municipal sewage treatment plant for Brandon, Manitoba revealed a lack of reliable design information on low temperature nitrogen removal rates and corresponding temperature correction factors. A study was initiated to evaluate the rates of nitrogen removal at the prevailing winter and spring temperatures in a sequencing batch reactor. The study used four parallel reactors: two 8 hr cycle and two 12 hr cycle reactors, all utilizing 2 hr anoxic fill and mix and 2 hr settle and decent periods per cycle. Temperature was lowered incrementally from 15 to 7 C, 5 to 2 C. The hydraulic retention time was 24 hr. Raw sewage mixed with the high-in-nitrogen pharmaceutical wastewater was used. At 15 C there was little difference in nitrification between the 8 and the 12 hr cycle reactors. At and below 7 C the 12 hr cycle reactors exhibited superior nitrification rates and inferior denitrification rates in comparison to the 8 hr cycle reactors. Response to the decrease in temperature was discontinuous. The temperature correction factors were: theta (nitrification) = 1.02 (15-7 C), and theta (nitrification) = 1.40 (<7-2 C). For denitrification, the effects of temperature were represented by: theta (denitrification) = 1.06 (15-7 C) and theta (denitrification) = 1.30 (<7-2 C). The minimum specific nitrogen removal rates, at 2 C were: K (nitrification) = 8 gN/kg VSS/d and K (denitrification) = 3-6 gN/kg VSS/d. (Author's abstract)
W89-06192

PARTITIONING OF CHLOROMETHANES BETWEEN AQUEOUS AND SURFACTANT MICELLAR PHASES,
Louisiana State Univ., Baton Rouge. Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5B.
W89-06193

DECOMPOSITION OF EXOPOLYSACCHARIDE SLIME BY A BACTERIOPHAGE ENZYME,
Wisconsin Univ.-Milwaukee. Dept. of Biological Sciences.
T. C. Nelson, J. Y. C. Huang, and D. Ramaswami.
Water Research WATRAG, Vol. 22, No. 9, p 1185-1188, September 1988. 5 fig, 29 ref.

Descriptors: *Dewatering, *Sludge drying, *Sludge thickening, *Slime, Enzymes, Bacteriophage, Sludge solids, Wastewater treatment, Decomposition, Viruses.

The objective of dewatering waste activated sludges is to remove water and to reduce the cost of subsequent treatment and disposal operations. A major impediment to effective dewatering by various mechanical devices is the ability of the waste activated sludge to hold copious quantities of water due to the presence of exopolymers, predominantly polysaccharides. A bacterial virus-encoded endodepolymerase has been shown to decompose exopolysaccharide slime produced by its sewage sludge-derived bacterial host. Substantial viscosity reduction and increased centrifugal compaction of a single slime-producing microbial slurry were achieved on enzyme addition. This demonstrates the feasibility of improving mechanical dewatering of biological sludges by use of enzymes in which the slime entrapped water is released and becomes more readily available for separation from the sludge solids matrix. (Geiger-PTT)
W89-06194

DISTRIBUTION COEFFICIENTS FOR CHEMICAL COMPONENTS OF A COAL-OIL/WATER SYSTEM,
Argonne National Lab., IL. Biological, Environmental, and Medical Research Div.
For primary bibliographic entry see Field 5B.
W89-06195

PERFORMANCE OF PILOT AND FULL-SCALE VERTICAL SHAFT AERATORS,
Newcastle upon Tyne Univ. (England). Dept. of Chemical Engineering.
J. R. Backhurst, J. H. Harker, and S. N. Kaul.
Water Research WATRAG, Vol. 22, No. 10, p 1239-1243, October 1988. 9 fig, 5 ref.

Descriptors: *Aeration, *Vertical shaft aerators, *Wastewater treatment, Pilot plants, Wastewater facilities, Dissolved oxygen, Performance evaluation, Design criteria.

The performance of aerators used in wastewater treatment plants was evaluated in a series of both pilot-scale and full-scale trials in which variables included aerator diameter, the number and size of blades, submergence, and depth of the water. After deaeration had been completed, the dissolved

oxygen level was measured as a function of time and hence the mass transfer coefficients, oxygenation capacities, and oxygenation efficiencies were determined. In all the tests, both at pilot-scale and full-scale operation, the oxygenation capacity was enhanced by increased rotational speed, tank size, number of blades, and aerator diameter, and optimum values of the speed and submergence were indicated. Empirical correlations of the data, specific to the systems investigated, have been made that may be applicable to other aerator designs. (Author's abstract)
W89-06219

SELECTIVITY OF BIOSORPTION OF HAZARDOUS ORGANICS BY MICROBIAL BIOMASS,
McMaster Univ., Hamilton (Ontario). Dept. of Chemical Engineering.
J. P. Bell, and M. Tsezos.
Water Research WATRAG, Vol. 22, No. 10, p 1245-1251, October 1988. 6 fig, 4 tab, 13 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Biosorption, *Biomass, *Pesticides, Activated sludge, Organic compounds, Chemical competition, Lindane, Pentachlorophenol, Diazinon, Malathion, Fungi, Adsorption.

Biosorption isotherms by two types of microbial biomass (activated sludge and Rhizopus arrhizus) were determined from multisolute solutions for four hazardous organic compounds (lindane, pentachlorophenol, diazinon, and malathion). The selectivity of the biosorption was quantified using the bioconcentration factors. For the compounds that are biosorbed (lindane, pentachlorophenol, and diazinon) and within the range of the pollutant concentrations found in wastewater treatment plants, the competition effects usually were minimal. Analysis of the competitive biosorption data, assuming a surface filling mechanism, suggests that biosorption of hazardous organic compounds cannot be described adequately by a simple adsorption hypothesis. (Author's abstract)
W89-06220

DEXTRAN BLUE COLORANT AS A RELIABLE TRACER IN SUBMERGED FILTERS,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
B. Jimenez, A. Noyola, B. Capdeville, M. Roustan, and G. Faup.
Water Research WATRAG, Vol. 22, No. 10, p 1253-1257, October 1988. 3 fig, 5 tab, 9 ref.

Descriptors: *Wastewater treatment, *Dye releases, *Tracer studies, *Submerged filters, *Wastewater facilities, Performance evaluation, Comparison studies, Spectrophotometry, Tailing phenomenon, Diffusion, Adsorption, Dextran blue.

A reliable method to evaluate residence time distribution in submerged filters of the type used for wastewater treatment is presented. The method is useful even when a porous packing is used. The tracer employed is Dextran blue 2000, which is detected better in the UV-zone (220 nanometers). In the first series of experiments four colorants were compared (bromophenol blue, mordant violet, bromocresol green, and eosin Y). Based on these results, it was concluded that diffusion was responsible for the observed tailing phenomena. Dextran blue 2000 then was tested because of its known lower diffusion characteristics. The advantage of this colorant is that it avoids the tailing phenomenon, allowing accurate mean retention time evaluation. The tailing phenomenon is explained here using the diffusion theory, in contrast to the commonly held view that adsorption is responsible. (Rochester-PTT)
W89-06221

FISH PRODUCTION IN SMALL OXIDATION PONDS,
Murdoch Univ. (Western Australia). School of Environmental and Life Science.
T. J. Wrigley, D. F. Toerien, and I. G. Gaigher.
Water Research WATRAG, Vol. 22, No. 10, p 1279-1285, October 1988. 2 fig, 3 tab, 42 ref.

Descriptors: *Aquaculture, *Wastewater treatment, *Fish, *Oxidation ponds, *Biological wastewater treatment, Seasonal variation, Water temperature, Dissolved oxygen, Mortality, Ammonia, Performance evaluation, Suspended solids, Chemical oxygen demand, Chlorophyll a, Eutrophic water.

Four 10-cu m pilot-scale oxidation ponds linked in series were stocked with Clarius gariepinus (first three ponds). On various occasions, combinations of Oreochromis mossambicus, Hypopthamichthys molitrix, Cyprinus carpio, and Labeo umbratus were stocked in the fourth and last pond. During summer, O. mossambicus and C. carpio had average relative daily growth rates of 1.4 and 2.1%, respectively, whereas in winter both H. molitrix and L. umbratus lost weight and C. carpio grew more slowly. Small C. gariepinus (<2 g) grew rapidly in summer (relative daily growth rate of 5.9%), but during winter, relative daily growth was reduced to 0.2%. Large C. gariepinus (>300 g) grew during summer at 0.5% body wt/day. Extrapolated yields of 3-4 tons/ha of C. gariepinus and 2-3 tons/ha of O. mossambicus and C. carpio could be harvested from large scale oxidation pond systems. Low winter temperatures and low dissolved oxygen concentrations during spring restrict production. Mass mortality of fish occurred during summer, probably due to oxygen deficiency and high unionized ammonia concentrations. Large reductions in total suspended solids, chlorophyll a, and COD were achieved in the fourth pond, but the role of fish in these reductions could not be determined. The dual role of fish production and improvement of water quality by fish stocking appears to be a feasible management option for sewage-oxidation ponds and further studies in this area are warranted. (Author's abstract)
W89-06224

RECIRCULATION IN A SMALL SEWAGE POND SYSTEM,
Murdoch Univ. (Western Australia). School of Environmental and Life Science.
T. J. Wrigley, D. F. Toerien, A. Moller, and A. J. H. Pieterse.
Water Research WATRAG, Vol. 22, No. 10, p 1287-1292, October 1988. 1 fig, 5 tab, 18 ref.

Descriptors: *Stabilization ponds, *Recirculation, *Biological wastewater treatment, *Wastewater treatment, *Wastewater facilities, Dissolved oxygen, Photosynthesis, Ammonia, Algal growth, Primary productivity, Chemical oxygen demand, Suspended solids, Performance evaluation, Algae.

Recirculation in a small scale waste stabilization pond system was maintained over a period of 12 mo. Effluent from the third pond in a series of four ponds was added to the first pond at a ratio of 1:1 (recirculated effluent:settled sewage effluent). Recirculation was stopped during winter for 35 days and during summer for 21 days to ascertain the seasonal benefits of recirculation. Dissolved oxygen concentration in pond 1 increased by up to 234% during recirculation in summer, reducing the potential of algal photosynthesis inhibition by high concentrations of ammonia-N. Algal cell numbers did not increase significantly in pond 1 during recirculation. Recirculation did not reduce total suspended solids and COD concentrations in the final effluent to meet government effluent standards of 25 and 75 mg/L, respectively. An increased recirculated effluent:settled sewage ratio is recommended. (Author's abstract)
W89-06225

CALCIUM DEPENDENCE OF THE FILAMENTOUS BACTERIUM HALISCOMENOBACTER HYDROSSIS,
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.). Inst. fuer Biotechnologie.
L. E. Webb.
Water Research WATRAG, Vol. 22, No. 10, p 1317-1320, October 1988. 4 fig, 11 ref.

Descriptors: *Bacteria, *Wastewater treatment, *Wastewater facilities, *Limiting nutrients, *Calcium, Bacterial growth, Morphology, Microscopy, Bacterial physiology, Sludge, Animal wastes.

A bacterium isolated from high rate algal ponds for the treatment of piggery wastes, and having an apparent calcium dependence, was compared with Haliscomenobacter hydrossis DSM 1100, which is frequently found in bulking sludge, and the growth factor requirements of both organisms were studied. The results show that the filamentous bacterium H. hydrossis and the new isolate 0132 need Ca(2+) for growth. Mounts of these bacteria in India ink viewed under the microscope revealed that both have sheathed filaments. It is speculated that the calcium may be necessary for sheath formation. Isolate 0132 grew rapidly on nutrient agar, whereas H. hydrossis did not. (Author's abstract)
W89-06229

ADSORPTION OF PYRIDINE ONTO SPENT RUNDLE OIL SHALE IN DILUTE AQUEOUS SOLUTION,
Queensland Univ., Brisbane (Australia). Dept. of Chemical Engineering.
S. Zhu, P. R. F. Bell, and P. F. Greenfield.
Water Research WATRAG, Vol. 22, No. 10, p 1331-1337, October 1988. 5 fig, 4 tab, 30 ref.

Descriptors: *Wastewater treatment, *Oil wastes, *Oil shale, *Adsorption, *Pyridines, Cations, Montmorillonite, Minerals, Solute transport, Organic compounds, Mine wastes, Langmuir isotherms, X-ray diffraction, Path of pollutants, Ion exchange.

The adsorption of pyridine from aqueous solutions onto the solids generated by the processing of oil shale originating from the Kerosene Creek seam of the Rundle deposit, Queensland, Australia, shows that the adsorption isotherm is of Langmuir type (L-4) with two plateaus. Cations that are leached from the spent shale or are in retort water (Na, K, Ca, NH4) have a marked effect on the adsorption; the anion effect, while measurable, is much less. The adsorption is controlled by a number of factors such as pyridine co-ordination, surface protonation and ion exchange. X-ray diffraction studies show that the montmorillonite in the spent shale expands during the sorption process, indicating a re-orientation of the adsorbed pyridine. The results identify some of the mechanisms likely to control the transport and removal of N-heterocyclic compound in spent shale waste dumps. (Author's abstract)
W89-06231

AUTOMATION AND CONTROL: GENERAL CONCEPTS AND THEIR APPLICATION IN WATER SUPPLY AND WASTE DISPOSAL SYSTEMS,
For primary bibliographic entry see Field 5F.
W89-06235

PROCEDURE FOR ESTIMATING THE CAPITAL COST OF ONTARIO WASTEWATER TREATMENT PLANT USING CAPDET,
McMaster Univ., Hamilton (Ontario). Dept. of Chemical Engineering.
D. G. Wright, G. G. Patry, C. E. Letman, and D. R. Woods.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 799-806, October 1988. 6 tab, 20 ref.

Descriptors: *Model studies, *Computer models, *Wastewater treatment, *Wastewater facilities, *Capital costs, Costs, Cost analysis, Estimated costs, Construction costs, CAPDET, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, Ontario, Canada.

CAPDET is a computer-assisted procedure for the design and evaluation of wastewater treatment facilities developed by the U.S. Army Corps of Engineers and the Environmental Protection Agency. Ten Canadian wastewater treatment plants were studied which included many of the treatment processes used in Canada. Six plants were used to develop the procedure while four plants were used to verify the procedure. The design flow for the selected plants ranged between 550 and 13,600 cu m/d. Construction cost estimates

generated using site-specific design information were compared with those obtained using the default database provided in CAPDET. The importance of the various unit costs on the total plant cost was also determined. Under the proposed methodology, unit costs are first adjusted to the date of construction using appropriate inflation indices. Wall concrete is increased by 15%, slab concrete by 50%, and excavation costs by 25% to account for differences in construction practice. A final estimate reduction of 15% is performed to account for Canadian conditions. The procedure provides construction cost estimates that are within plus or minus 20% of actual construction costs with a mean absolute error of 11% and an average error of 2.3%. Site-specific design data had little effect on the construction cost estimates with the exception of lagoon treatment facilities. Utilities and support facilities accounted for 20-30% of the cost estimates. The most significant cost parameters were the inflation index values and concrete and building unit costs. (Author's abstract)
W89-06243

HEAD LOSSES AT MANHOLES WITH A 90 DEGREE BEND,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
For primary bibliographic entry see Field 8B.
W89-06245

MASS BALANCE DURING SUBSOIL IRRIGATION OF DOMESTIC SEWAGE: EXPERIMENTAL SET-UP AND PRESENT RESULTS (STOFFBILANZ IM SYSTEM BODEN-BODENLUFT-WASSER BEI DER ABWASSERVERSICKERUNG: VERSUCHSAUFBAU UND ERSTE ERGEBNISSE),
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
S. Rettinger, and W. Bischofsberger.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 182-188, October 1988. 8 fig, 3 tab, 7 ref.

Descriptors: *Soil disposal fields, *Septic tanks, *Domestic wastes, *Wastewater treatment, Experimental design, Aeration zone, Seepage, Lysimeters, Soil columns, Soil types, Organic carbon, Ammonium, Nitrogen, Phosphorus, Soil gases, West Germany.

Eight percent of the inhabitants of the Federal Republic of Germany will continue to discharge their wastewater into the soil after pretreatment in septic tanks. Such underground disposal utilizes the purification efficiency of the unsaturated zone. Since knowledge of the quantitative effects and mass balance is poor, investigations were conducted using lysimeters and a full-scale outdoor plant. Four columns with loess, fine sand, medium-coarse sand, and gravel were used for comparison studies in naturally-occurring loose sediments. An especially-suitable lysimeter type was installed. The main difference from conventional lysimeters consisted of the separation of the collection area into a central and a lateral part. Through this partition of the flow, possible eddy currents at the column wall could be measured separately in the lateral chamber. For investigations on a technical scale, a drainage line for one population equivalent was established. The results so far show that an extensive reduction of biological substances takes place in the unsaturated soil zone. After seeping about 1 m from the sewage source, the water contained no increased concentration of dissolved organic carbon, ammonium, organic nitrogen, nor total phosphorus. Quantitative investigations of soil gas chemistry demonstrated that biological activity appears to take place only in a very limited zone. (Shidler-PTT)
W89-06283

EFFECTS OF LOW CONCENTRATIONS AND SHORT-PERIOD LACK OF DISSOLVED OXYGEN UPON THE ORGANISMS OF THE CONCOMITANT BIOCENOSIS IN ACTIVATED SLUDGE,
Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
M. Toman, and M. Rejic.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 189-193, October 1988. 6 fig, 3 tab, 12 ref.

Descriptors: *Activated sludge, *Dissolved oxygen, *Oxygen requirements, *Species composition, *Anaerobic treatment, *Biological wastewater treatment, Mortality, Protozoa, Rotifers, Bacteria, Aeration, Municipal wastewater.

The effects of short-term lack of dissolved oxygen and of an anoxic environment upon the populations in activated sludge were simulated in a laboratory biological-treatment plant and in an open respirometer. Mortality rates of ciliates and rotifers were monitored. The tests proved that a 24-hour cessation in aerating activated sludge in the laboratory treatment did not essentially affect the treatment of municipal wastewater nor the biocenosis of activated sludge. Some influences of low dissolved-oxygen concentration and short-term anoxia on the population of the biocenosis were noticed when testing with the open discontinuous respirometer. However even in this case the biocenosis was capable of quick regeneration with the introduction of effective aeration, which seems to be of essential importance for biological-treatment plants. The tests also showed that the greatest effects of lack of oxygen could be noticed in peritrichs--Vorticella convalaria and Opercularia coarctata. As these are the organisms that intensively filter the dispersed bacteria of the activated sludge, lack of dissolved oxygen or short anoxic periods might be the reason for a muddy state of the effluent of biological-treatment plants. The greatest resistance to the influences of anoxic environment were noticed for Paramecium caudatum, Vorticella microstoma, and Aspidisca costata. (Shidler-PTT)
W89-06284

DETERMINATION OF TOXICITY OF ZINC SULFATE, COPPER SULFATE AND PHENOL BY MEANS OF DIFFERENT METHODS (TOXIZITATSBESTIMMUNG VON ZINKSULFAT, KUPFERSULFAT UND PHENOL ANHAND VERSCHEIDENER METHODEN),
Politechnika Slaska, Gliwice (Poland). Inst. fuer Umweltschutztechnik.
K. Miksch, and B. Schurmann.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 193-198, October 1988. 7 fig, 3 tab, 20 ref. English summary.

Descriptors: *Activated sludge, *Toxicity, *Sulfates, *Phenols, Microbial studies, Comparison studies, Zinc, Copper.

The toxic effects of zinc sulfate, copper sulfate, and phenol on mixed microorganism populations of activated sludge were determined by means of the following methods: (a) rate of substrate consumption in a batch reactor, (b) dehydrogenase activity (TTC test), and (c) oxygen uptake (respiration activity). The effect of the substances studied on microorganisms could be described by the following equation: TG = TGMAX x (C / (K + C)), where TG = degree of toxicity in per cent, TGMAX = maximum TG for the particular measuring method, C = concentration of the toxic substance, and K = a constant value specific for the particular substance. The values of EC50 for copper sulfate were similar in all the methods used, but for zinc sulfate and phenol great differences were observed. Hence, when giving the values of EC20, EC50, and EC80 it is necessary to state which method was used to determine the value. (Author's abstract)
W89-06285

EFFECT OF INITIAL CONCENTRATIONS OF NITRATES AND NITRITES ON THE DENITRIFICATION BY THE BACTERIA OF PSEUDOMONAS GENUS,
Adam Mickiewicz Univ., Poznan (Poland). Lab. of Kinetics and Catalysis.
A. Juszczak, and F. Domka.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 199-202, October 1988. 6 fig, 3 tab, 7 ref.

Descriptors: *Wastewater treatment, *Pseudomonas, *Nitrates, *Nitrites, *Denitrification, *Culture media, Nitrogen compounds, Nitrogen removal, Chemical reactions, Enzymes, Kinetics, Soil bacteria, Biological wastewater treatment.

The denitrification by Pseudomonas incubated in nitrate, nitrite, and mixed nitrate/nitrite media with different initial concentrations of nitrate nitrogen and nitrite nitrogen was studied. Changes in concentrations of all inorganic nitrogen compounds in the media were plotted as a function of the reduction time for all the media examined. The data presented show that rate constants of the stages of nitrate reduction are functions of initial nitrate concentrations. Such a dependence should not occur in a first-order reaction, but it must be kept in mind that these rate constants represent observed constants depending upon enzyme concentration, which changes with the reaction time. The data show that a complete reduction of nitrites proceeds at an initial concentration of nitrite nitrogen not exceeding 1.4 g/cubic dm and the ratio of C/N > or = 1.2. When initial concentration of nitrite nitrogen is equal to 1.7 g/cubic dm (C/N = 0.9), the extent of reduction is 40%. In the series of experiments with nitrite media, a dependence of the reduction rate constant on the initial nitrogen concentration was observed for a reason analogous to that mentioned in the case of nitrate media. The decrease of the first reaction stage with the rise in initial concentration of nitrate nitrogen is caused by the fact that nitrites are competitive electron acceptors for nitrates. It is concluded that Pseudomonas bacteria could be used for the treatment of waste waters rich in nitrates and nitrites. (Shidler-PTT)
W89-06286

OCCURRENCE AND BEHAVIOUR OF LINEAR ALKYLBENZENESULPHONATES, NONYLPHENOL, NONYLPHENOL MONO- AND NONYLPHENOL DIETHOXYLATES IN SEWAGE AND SEWAGE SLUDGE TREATMENT,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
P. H. Brunner, S. Capri, A. Marcomini, and W. Giger.
Water Research WATRAG, Vol. 22, No. 12, p 1465-1472, December 1988. 6 fig, 2 tab, 12 ref.

Descriptors: *Wastewater analysis, *Wastewater treatment, *Sludge, *Alkylbenzene sulfonates, *Surfactants, *Phenols, Switzerland, Wastewater facilities, Chromatography, Anaerobic digestion, Path of pollutants, Pollutant identification.

The fluxes of linear alkylbenzenesulfonates (LAS), nonylphenol (NP), nonylphenol monoethoxylate (NP1EO) and nonylphenol diethoxylate (NP2EO) through sewage and sludge treatment of 29 Swiss sewage treatment plants were investigated. Reversed-phase high-performance liquid chromatography (HPLC) was used to determine LAS. Normal-phase HPLC was employed to measure NP, NP1EO and NP2EO, which are metabolites of the nonionic surfactants of the nonylphenol polyethoxylate type (NPnEO). Quantitative determinations were performed of raw sewage, primary and secondary effluents and of sewage sludge. Under normal conditions of sewage and sludge treatment, LAS were efficiently removed from the raw wastewater (> 99% w/w) and were partly transferred to the sewage sludge (15-20% w/w). About 50% (molar base) of NPnEO in the sewage were transformed to NP and accumulated in the digested sludge. Large variations existed among different sewage treatment plants. It was estimated that 1.0 g/sq m/y of LAS and 0.3 g/sq m/y of NP are applied with sewage sludge to Swiss soils. (Author's abstract)
W89-06292

IMPROVED METHOD USING RESPIROGRAPHY FOR THE DESIGN OF ACTIVATED SLUDGE AERATION SYSTEMS,

Kemijski Inst. Boris Kidric, Ljubljana (Yugoslavia).
M. Ros, M. Dular, and P. A. Farkas.

Water Research WATRAG, Vol. 22, No. 12, p 1483-1489, December 1988. 5 fig, 10 tab, 17 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Respiration, *Activated sludge process, *Aeration, *Oxygen uptake, Industrial wastewaters, Aerobic treatment.

For the optimal operation of an aerobic biological treatment plant with activated sludge, oxygen should be introduced in sufficient quantities into the aeration tank of the biological plant. For the computation of oxygen uptake, several methods are available such as the OC/L (oxygenation capacity/load) method, Emde's method with fixed coefficients, Eckenfelder's method, and the method of levels of dissolved oxygen. A method for the determination of oxygen uptake for the treatment of industrial wastewaters was developed. The method is based on respirometry of the activated sludge. The advantages of the method are: the individual phases of oxygen are determined (endogenous and exogenous phase), all of the measurements are determined with real activated sludge from the aeration tank at precisely defined loading of the biological treatment plant, and the method is relatively fast (the results can be obtained in a few hours). It is proposed that the respirometric method be used for the estimation of oxygen uptake for newly connected wastewater in biological treatment plants. (VerNooy-PTT)
W89-06294

OLIVE MILLS WASTEWATER TREATMENT BY COMBINED MEMBRANE PROCESSES,

Genoa Univ. (Italy). Inst. of Industrial Chemistry.
P. Canepa, N. Marignetti, U. Rognoni, and S. Calgari.

Water Research WATRAG, Vol. 22, No. 12, p 1491-1494, December 1988. 4 fig, 5 tab, 16 ref.

Descriptors: *Olive mills, *Reverse osmosis, *Ultrafiltration, *Wastewater treatment, *Membrane processes, *Food-processing wastes, Filtration, Adsorption, Pilot plants.

Olive mills wastewater, commonly called vegetation water, is formed during industrial extraction of oil from olives and its physico-chemical characteristics vary with place, age of growth, season, year, etc. The purpose of this work was to verify the combined application of membranes and adsorption processes to the treatment of vegetation waters coming from olive oil factories. The described pilot plant worked for about 6 months using polysulfone ultrafiltration membranes, absorbing polymers and polypiperazine amide reverse osmosis membranes. The process was optimized, so that from wastewater entering with a COD content of about 90,000 ppm it was possible to obtain a COD reduction of about 99% with the recovery of polyphenols to use in alimentary industries and of a 'concentrated paste' for oil extraction, furfural production or combustion. Also evaluated was the economical feasibility of industrial application calculating that the total cost of the treatment was close to 3 c per liter. (Author's abstract)
W89-06295

BEHAVIOR OF NITROGEN AND PHOSPHORUS DURING BATCH AEROBIC DIGESTION OF WASTE ACTIVATED SLUDGE: CONTINUOUS AERATION AND INTERMITTENT AERATION BY CONTROL OF DO,

Ehime Univ., Matsuyama (Japan). Dept. of Resource Chemistry.
A. Matsuda, T. Ide, and S. Fuji.

Water Research WATRAG, Vol. 22, No. 12, p 1495-1501, December 1988. 9 fig, 2 tab, 9 ref. Ministry of Education, Science and Culture of Japan, Grant-in-Aid for Scientific Research 60303020.

Descriptors: *Aerobic digestion, *Nitrogen, *Phosphorus, *Activated sludge, *Aeration, *Dissolved oxygen, *Wastewater treatment, Sludge digestion, Sludge solids, Biomass, Suspended solids, Municipal wastewater.

The purpose of this study is to find the behavior of nitrogen and phosphorus during aerobic digestion. Waste activated sludge samples from a municipal wastewater treatment plant were digested under 30 days batch operation, aerating continuously and intermittently. If the cycle time of intermittent aeration was decided so that the DO in a digestion tank did not become zero, the reduction rate of sludge solids and the behavior of nitrogen and phosphorus in the intermittent aeration were similar to those in the continuous aeration. The percentage of biomass nitrogen and phosphorus in the initial total nitrogen or phosphorus decreased and finally became 20% for N and 30% for P. Forty per cent of the initial suspended solids remained finally. On the other hand, the percentage of liquid phase nitrogen and phosphorus increased during digestion and reached 60% for N and 70% for P. It is believed that a considerable portion of the initial total nitrogen and phosphorus remains in the liquid phase after aerobic digestion under sufficient oxygen supply. The amounts of nitrogen and phosphorus in the residual biomass increased a little and decreased thereafter. Also, amounts of them in reduced biomass increased uniformly. (Author's abstract)
W89-06296

UPGRADING A FACULTATIVE POND BY IMPLANTING WATER HYACINTH,

Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
H. M. Orth, and D. P. Sapkota.

Water Research WATRAG, Vol. 22, No. 12, p 1503-1511, December 1988. 6 fig, 5 tab, 21 ref.

Descriptors: *Filter crops, *Water hyacinth, *Biological wastewater treatment, *Wastewater treatment, *Nutrient removal, Dissolved oxygen, Effluents, Chemical oxygen demand, Suspended solids, Thailand, Oxidation process.

Water hyacinth was implanted in one of two existing facultative ponds and both units were operated in parallel under comparable conditions. The ponds were fed with mainly domestic wastewater after pretreatment in anaerobic ponds and operated at a BOD sub 5-loading of about 48 kg/ha/d and a detention time of 12 days. A period of 4 months, from the implantation of the water hyacinths until no further systematic change in the treatment efficiency of the water hyacinth pond was observed is described. The median effluent concentrations of the facultative pond were 55 mg/L for suspended solids, 95 for chemical oxygen demand, 6.4 for total Kjeldahl nitrogen, and 1.4 mg/L for total phosphorus. The values for the water hyacinth pond were 12, 26, 2.5 and 0.4 mg/L, respectively. The average dissolved oxygen effluent concentration of the water hyacinth pond was 1.2 mg/L, but this still increased slightly as compared to the influent. The study demonstrates that the implantation of water hyacinth is an appropriate option for upgrading facultative ponds. In many cases where more stringent effluent standards are imposed, the method may be a suitable alternative to technical treatment processes. (Author's abstract)
W89-06297

COMBINED AEROBIC HETEROTROPHIC OXIDATION, NITRIFICATION AND DENITRIFICATION IN A PERMEABLE-SUPPORT BIOFILM,

Oregon State Univ., Corvallis. Dept. of Civil Engineering.
D. L. Timberlake, S. E. Strand, and K. J. Williamson.

Water Research WATRAG, Vol. 22, No. 12, p 1513-1517, December 1988. 4 fig, 1 tab, 22 ref.

Descriptors: *Heterotrophic bacteria, *Wastewater treatment, *Aerobic treatment, *Wastewater oxidation, *Biofilms, *Nitrification, *Denitrification, Membranes, Oxidation, Biological wastewater treatment.

A biofilm reactor, termed the permeable-support biofilm (PSB), was developed in which oxygen was supplied to the interior of the biofilm through a permeable membrane. The reactor was tested on filtered sewage supplemented with nutrient broth; the bulk solution was anoxic and the interior of the biofilm was supplied with pure oxygen. All tests were performed on a non-steady state biofilm with a depth of 1 mm. Mass balances on total organic carbon, ammonia, organic nitrogen and nitrate showed that combined heterotrophic oxidation of organics, denitrification and nitrification occurred simultaneously within the biofilm. The advantages of such a reactor are discussed, and the measured removal rates of organic carbon, ammonia and nitrate in these preliminary studies of the PSB reactor are sufficiently high to warrant further research. (Author's abstract)
W89-06298

EXTERNAL MASS TRANSPORT PROCESSES DURING THE ADSORPTION OF DYES ONTO BAGASSE PITH,

Queen's Univ., Belfast (Northern Ireland). Dept. of Chemical Engineering.
G. McKay, M. El Geundi, and M. M. Nassar.

Water Research WATRAG, Vol. 22, No. 12, p 1527-1533, December 1988. 12 fig, 6 tab, 4 ref.

Descriptors: *Wastewater treatment, *Mass transfer, *Dye industry wastes, *Bagasse pith, *Adsorption, Kinetics, Mathematical models, Dyes.

The removal of dyes from effluent in an economic fashion remains a major problem, although recently a number of successful systems have been designed using adsorption techniques. In adsorption processes, the effective rate of adsorption is determined by one or more of several steps, and the process modeling is complex. In this study the kinetics of the adsorption of four dyestuffs onto bagasse pith has been examined. Two basic dyes, Basic Blue 69 and Basic Red 22, and two acid dyes, Acid Blue 25 and Acid Red 114, were used in an agitated batch adsorber. The external mass transfer coefficient has been found to vary linearly with agitation, initial dye concentration, pith mass, pith particle size and dye solution temperature. A model is proposed to determine the external mass transfer coefficients for the systems and these are correlated with the system variable. The model, however, is subject to certain limitations. First, the dye solution and pith particles are quite complex systems. Secondly, pith particles are not true homogeneous spheres and assigning a representative specific surface to pith is difficult. (VerNooy-PTT)
W89-06300

DOSE-RESPONSE OF ESCHERICHIA COLI IN OZONE DEMAND-FREE PHOSPHATE BUFFER,

Alberta Univ., Edmonton. Dept. of Civil Engineering.
G. R. Finch, D. W. Smith, and M. E. Stiles.

Water Research WATRAG, Vol. 22, No. 12, p 1563-1570, December 1988. 7 fig, 1 tab, 28 ref.

Descriptors: *Escherichia coli, *Water treatment, *Wastewater treatment, *Phosphates, *Ozonation, *Disinfection, Water quality standards, Kinetics, Regression analysis, Water treatment, Bacteria, Experimental design.

The intention of this investigation was to determine the mean response of E. coli at predetermined ozone dose levels. By using replicated, randomized, independent batch experiments, precise estimates of the response could be obtained. Particular care was taken in preparing the bacteria and glassware to eliminate effects caused by extraneous ozone demand. A total of 57 batch experiments were conducted at bench-scale using ozone doses of 4.4, 11, 45, 200 and 800 micrograms/L at contact times of 30, 60 and 120 s. The logarithm of the E. coli survival ratio was plotted as a function of applied ozone dose, utilized ozone, and contact time. Contact time was found to have some effect for intermediate doses of ozone, but the effects were small relative to those associated with the utilized ozone dose. It was also found that the disinfection reaction was not first-order with respect to the surviving bacteria concentration and

two distinct stages were observed; an initial rapid inactivation stage followed by a slower inactivation stage. Regression analysis of the E. coli response on the logarithm of the dose parameter is typical of dose-response models for water and wastewater disinfection. However, this model form was inadequate when fitted to the data of this study as a result of a significant tailing effect in the log-log dose-response plots. It was postulated that the observed dose-response could be explained by chemical kinetic theory and that the dose-response was affected by the disinfection reaction rates which were dependent upon the surviving number of bacteria and the residual ozone concentration. For practical application, it was found that an adequate dose-response model for 0-99.99% reduction of E. coli could be developed using the logarithm of utilized ozone as the dose function. (Author's abstract)
W89-06304

ANAEROBIC TREATMENT OF DOMESTIC SEWAGE WITH A ROTATING-STATIONARY FIXED-FILM REACTOR,
Institut National des Sciences Appliquees de Lyon, Villeurbanne (France). Lab. de Chimie et Genie de l'Environnement.
A. Noyola, B. Capdeville, and H. Roques.
Water Research WATRAG, Vol. 22, No. 12, p 1585-1592, December 1988. 9 fig, 7 tab, 17 ref.

Descriptors: *Wastewater treatment, *Packed beds, *Domestic wastes, *Anaerobic digestion, Wastewater facilities, Films, Filters, Chemical oxygen demand, Performance evaluation.

An anaerobic reactor was developed for on-site and small scale wastewater treatment applications. The up-flow fixed-film reactor was packed with two different types of circular media: stationary and rotating. Experimental results showed the reactor can treat primary settled domestic wastewaters efficiently, under different operating conditions. At 29 C the mixing action did not improve the organic matter removal efficiencies (65% COD removal was obtained with an organic load of 1.7 kg COD/cu m/day and a 6 h space time). However, at 16 C the removal efficiency was greatly dependent on the mixing conditions: a gentle agitation (5 rpm) up-graded significantly the reactor operation, but no improvement was observed beyond 15 rpm. It appears that at low temperatures liquid-biofilm mass transfer is the rate limiting step when treating sewage anaerobically. Gas production was rather limited (0.11 cu m (STP)/kg COD removal) and calculations suggest that more than 50% of the total CH4 produced is lost due to its dissolution in the effluent. Improved effluent quality, reduced sludge production (0.11 kg TSS/kg COD supplied), low energy requirements and low maintenance needs make this reactor a good, compact alternative to conventional household wastewater treatment processes. (Author's abstract)
W89-06307

OCCURRENCE OF 'THERMOPHILIC' CAMPYLOBACTERS IN SEWAGE AND THEIR REMOVAL BY TREATMENT PROCESSES,
Reading Univ. (England). Dept. of Microbiology.
S. M. Arimi, C. R. Fricker, and R. W. A. Park.
Epidemiology and Infection, Vol. 101, No. 2, p 279-286, October 1988. 3 tab, 44 ref.

Descriptors: *Pathogenic bacteria, *Bacteria, *Wastewater treatment, *Wastewater analysis, *Sewage bacteria, *Trickling filters, Bacterial analysis, Campylobacters, England.

Removal of thermophilic campylobacters from sewage at three different stages of treatment at a trickling filter sewage works has been assessed. Samples of incoming sewage, primary sedimentation effluent and final effluent were taken daily from 0600 h to 2000 h for 5 consecutive days and the numbers of campylobacters determined by using a most probable number method. Each sample was cultured using 2 h pre-enrichment followed by enrichment in Preston broth for 48 h and detection by plating. Over 78% of the incoming campylobacters were removed after primary sedimentation and <0.1% remained in the final effluent. Campylobacter jejuni biotype I and biotype II constituted 81.5% and 15.9% respectively of the 232 isolates tested. Serotypes common in sewage were common in human feces. It appears that the trickling filter sewage works removes most of the campylobacters entering the sewage works, but large numbers, estimated to be approximately 10 to the 10th power, are released into the environment daily from a local sewage works. (Author's abstract)
W89-06309

MODEL TO QUANTIFY WASTEWATER ODOR STRENGTH,
National Univ. of Singapore. Dept. of Civil Engineering.
For primary bibliographic entry see Field 7B.
W89-06389

FRAMEWORK FOR TECHNOLOGICAL CHOICE (A TECHNOLOGY ASSESSMENT: METHODOLOGY FOR THE CHOICE OF WASTEWATER TREATMENT FACILITIES),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
D. Couillard.
Journal of Environmental Systems JEVSB, Vol. 18, No. 1, p 49-67, 1988. 2 fig, 6 tab, 26 ref.

Descriptors: *Management planning, *Wastewater treatment, *Wastewater facilities, *Model studies, Technology, Assessments, Economic aspects, Environmental effects, Public policy, Decision making.

Technological assessment is defined as a multidimensional process applied to a management model to make wise or best choices. A method of technological assessment is presented as well as its application to the choice of wastewater technology. The critical path used in the Quebec urban wastewater treatment program was analyzed using a grid made up of six dimensions, or domains, that can be considered when making a technology assessment study (technology, economics, environment, society, the individual, values and collective aspects of decision-making). This led to the identification of the most important criteria on which the selection of technologies was based; technical, economic, and environmental criteria were called upon much more often than those relating to society, the individual, or to values and collective aspects of decision-making. (Author's abstract)
W89-06402

NARRAGANSETT BAY POLLUTION CONTROL: AN EVALUATION OF PROGRAM OUTCOME,
Rhode Island Univ., Kingston. Dept. of Marine Affairs.
For primary bibliographic entry see Field 5G.
W89-06405

COMPETITIVE ADSORPTION OF ORGANIC COMPOUNDS BY MICROBIAL BIOMASS,
New Jersey Inst. of Tech., Newark. Dept. of Civil and Environmental Engineering.
A. Selvakumar, and H. Hsieh.
Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 729-744, 1988. 3 tab, 6 fig, 6 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Phenols, *Organic compounds, Organic wastes, Microbial biomass, Activated sludge.

The effect of competitive adsorption of liquid organic compounds on inactive microbial biomass (activated sludge and nitrifying biomass) in bisolute solution systems using phenol-nitrophenol, phenol-chlorophenol, nitrophenol-chlorophenol, and chlorobenzene-ethylbenzene systems was investigated. The adsorption process of liquid organic compounds by inactive microbial biomass can be expressed by the Freundlich adsorption isotherm. In the bisolute solution uptake of each solute on the biomass was reduced significantly relative to its value in pure solution. But the combined capacity is greater than that for either of the pure substances alone and it is less than either of the pure solutes would have shown at twice the concentration. The octanol/water partition coefficient is a better indicator of the relative extent of adsorption by inactive microbial biomass than the aqueous solubility. (White-Reimer-PTT)
W89-06408

CROP RECOVERY OF N15 FROM MICROALGAE GROWN IN SIMULATED INORGANIC-WASTEWATER MEDIUM,
Alabama A and M Univ., Normal. Dept. of Plant and Soil Science.
K. R. Sistani, and R. W. Taylor.
Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 745-755, 1988. 3 tab, 15 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Nitrogen removal, *Algae, Nitrogen, Fertilizers, Crop yield, Crop production, Bioaccumulation, Cyanophyta, Chlorophyta.

A greenhouse experiment was carried out using a Decatur silt loam soil to assess the availability and recovery of algal nitrogen which was grown in simulated inorganic-wastewater medium by grain sorgum. Dried green or blue-green algal biomass providing 175, 350 and 525 mg labeled N/kg of soil was used as a source of nitrogen. Grain sorghum plants assimilated 25 to 34% of total N applied as green algae and 24 to 45% as blue-green algae during 6 weeks of growth. These nitrogen applications increased the shoot yield by 94, 82, and 65% for green algae and 88, 61, and 61% for blue-green algae, respectively. No significant increase was observed for the application of algal biomass at a rate higher than 175 mg N/kg of soil. About 58 to 65% of total green algal N and 51 to 65% of total blue-green algal N remained in the soil. Six to 12% of the total N applied as green algae and 4 to 11% as blue-green algae biomass was unaccounted for. The results indicated that there was no significant difference between green and blue-green algal biomass with regard to their use as a source of plant nutrients. The results also encourage the use of algae as cleaning microorganisms for wastewater facilities and lagoons because the harvested algal biomass may be used as a source of plant nutrients to help reduce the cost of operations. (Author's abstract)
W89-06409

HEAVY METAL VARIABILITY OF DIFFERENT MUNICIPAL SLUDGES AS MEASURED BY ATOMIC ABSORPTION AND INDUCTIVELY COUPLED PLASMA EMISSION SPECTROSCOPY,
Washington Univ., Seattle. Dept. of Environmental Health.
For primary bibliographic entry see Field 5E.
W89-06412

POLLUTION CONTROL IN THE GULF COOPERATION COUNCIL (G.C.C.) COUNTRIES-HYDROLYZATION IN INDUSTRIAL WASTEWATER TREATMENT,
Kuwait Univ., Safat. Coll. of Engineering and Petroleum.
H. I. Shaban, G. A. Al-Enezi, and A. Qader.
Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 843-854, 1988. 3 tab, 2 fig, 4 ref.

Descriptors: *Wastewater treatment, *Fertilizers, *Industrial wastewater, *Water pollution control, Ureas, Nitrogens, Ammonia, Gulf Cooperative Council, Kuwait, Hydrolysis, Agricultural chemicals, Irrigation water.

The major aerial pollutants in the Arabian Gulf region are sulfur compounds, nitrogen compounds, and solid inorganic materials. In addition to sulfur and nitrogen compounds, carbon compounds including hydrocarbons and heavy metals are major pollutants in the coastal waters. The use of a hydrolyzation plant as a pollution control measure

to remove urea and ammonia in fertilizer wastewater has been examined. The method hydrolyzes urea to ammonia and carbon dioxide. The performance studies showed that the originally designed measures were sometimes inadequate to solve practical pollution problems. However, the addition of a small process deaeration unit solved them satisfactorily and both controlled the environmental pollution of sea water and obtained irrigation water and soil conditioner. (White-Reimer-PTT)
W89-06413

ANALYTICAL PROCEDURE FOR THE MEASUREMENT OF ATP EXTRACTED FROM ACTIVATED SLUDGE,
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 7B.
W89-06414

BREWERY WASTEWATER TREATMENT BY DEEP AERATION YEAST AND ACTIVATED SLUDGE PROCESS,
Wuhan Univ. (China).
C. Huang, Y. Hung, and H. H. Lo.
Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 247-251, December 1988. 6 tab, 10 fig, 4 ref.

Descriptors: *Wastewater treatment, *Biological wastewater treatment, *Activated sludge process, *Deep aeration, *Industrial wastewater, Brewery wastewater, Chemical oxygen demand, Biochemical oxygen demand, Suspended solids, Aeration.

A two-stage treatment process, using deep aeration yeast activated sludge followed by extra-deep aeration activated sludge process, was used in the treatment of brewery wastewater. The brewery wastewater contained 12,600 mg/L COD (chemical oxygen demand) and 9,500 mg/L BOD (biochemical oxygen demand). Stage 1 treatment process removed 86.3% COD and 89.6% BOD and produced 4,500 mg/L yeast in the effluent. Stage 2 treatment process, using extra-deep aeration activated sludge process, removed 94% COD and 98% BOD and had average specific sludge production 0.114 g sludge produced/g COD removed or 0.143 g sludge produced/g BOD removed. The yeast production rate was 0.414, and 0.529, based on COD, and BOD removal, respectively. The final effluent contained 60 mg/L COD, 11.7 mg/L BOD, and 13.1 mg/L total suspended solids. (Author's abstract)
W89-06419

KINETIC DESCRIPTION OF INDUSTRIAL WASTEWATER OZONATION PROCESSES,
Tallinn Polytechnic Inst. SSR.
S. Preis, R. Munter, and E. Siirde.
Ozone Science and Engineering OZSEDS, Vol. 10, No. 4, p 379-392, 1988. 6 fig, 2 tab, 8 ref.

Descriptors: *Ozonation, *Wastewater treatment, *Ozone, *Chemical oxygen demand, Kinetics, Model studies, Industrial wastewater, Organic carbon, Organic compounds, Mathematical studies.

Rate constants of ozone with different organic compounds in aqueous solution obtained from published literature as well as data on the ozonation kinetics of aqueous solutions and wastewater were analyzed. Chemical oxygen demand (COD) was used as a kinetic parameter from the solution side. On the basis of the results obtained from the ozonation of model solutions and wastewater, the rate coefficient by COD of the reaction was shown to be constant during separate stages of the process. Due to the consumption of fast-reacting components and entering into the reaction of more slowly reacting intermediate products, the rate coefficient changed spasmodically with transition from one stage to another. The reaction order with respect to the COD of the solution was shown to be equal to the reaction order with respect to the pure component. (Author's abstract)
W89-06478

PREVENTION AND REMEDIATION OF CONTAMINATED SITES WITH LININGS,
Butek Ltd., Essex (England).
J. A. Coulson.
Chemistry and Industry CHINAG, Vol. 21, p 692-694, November 1988. 4 fig, 3 tab.

Descriptors: *Wastewater treatment, *Landfills, *Soil contamination, *Water pollution prevention, *Rehabilitation, *Linings, Waste disposal, Polyethylene, Polymers, Leaching, Performance evaluation, Materials testing, England, The Netherlands.

High density polyethylene (HDPE) linings offer good overall chemical resistance and improved stress crack and flexibility at waste disposal sites. HDPE sheeting can be produced by flat dye extrusion or blow extrusion. On large sites HDPE is unrolled and positioned by a machine, but on smaller sites a combination of machinery and manual labor is required. Jointing may be carried out by an extrusion method or using hot air or heated wedge elements to fuse the material within an overlap joint. Joints may be tested by ultrasonic testing, vacuum box methods, air pressure testing, or low voltage copper wire testing. An HDPE-lined sewage treatment pond of 6,000 sq m, 2 mm thick was completed for North West Water Authority near Altca, Lancashire. Several landfill sites in the UK are currently using HDPE linings. In the Netherlands, HDPE linings have been used as a vertical water-tight plastic screen surrounding a refuse pit to prevent sideways contamination of a river or a lake. (Geiger-PTT)
W89-06494

OPTIMAL REMOVAL OF CHLOROLIGNIN BY ULTRAFILTRATION ACHIEVED BY PH CONTROL,
Lappeenrannan Teknillinen Korkeakoulu (Finland). Lab. of Physical Chemistry.
M. Nystroem, and M. Lindstroem.
Desalination DSLNAH, Vol. 70, No. 1-3, p 145-156, November 1988. 7 fig, 5 ref.

Descriptors: *Bleaching wastes, *Chlorolignin, *Ultrafiltration, *Wastewater treatment, *Pulp wastes, *Separation techniques, *Hydrogen ion concentration, Color, Industrial wastes, Retention, Pore size, Kraft mills, Molecular weight, Polyelectrolytes.

The ultrafiltration of chlorolignin fractionated from pine kraft pulp bleach effluent originating from the first caustic stage of the bleachery was studied at different chlorolignin concentrations and pH using polysulfone and sulfonated polysulfone membranes. Retention of chlorolignin increased along with pH and increasing degree of dissociation of chlorolignin, which is a low molecular weight anionic polyelectrolyte. Retention stayed very high, about 99%, at high pH values. This is remarkable as the chlorolignin molecule is considered to be much smaller than the pore size of the membranes used. The high electrostatic repulsion between the chlorolignin molecules and the membrane surface is obviously the reason for that. Flux reduction decreased remarkably along with pH increase as well. The results confirm that sufficient chlorolignin removal can be achieved if its ultrafiltration is carried out at pH = 10, which is approximately the pH of the first caustic stage in the bleach process. (Author's abstract)
W89-06499

REUSE OF REACTIVE DYE LIQUORS USING CHARGED ULTRAFILTRATION MEMBRANE TECHNOLOGY,
Natal Univ., Durban (South Africa). Dept. of Chemical Engineering.
A. Erswell, C. J. Brouckaert, and C. A. Buckley.
Desalination DSLNAH, Vol. 70, No. 1-3, p 157-167, November 1988. 6 fig, 2 tab, 15 ref.

Descriptors: *Dye industry wastes, *Membrane filters, *Wastewater treatment, *Ultrafiltration, *Water reuse, Color, Textile mill wastes, Dyes, Industrial wastes, Separation techniques, Electrolytes, Hydrogen ion concentration, Fouling, Recycling, Sodium hydroxide, Economic aspects, Salt rejection, Chemical precipitation, Environmental protection.

A closed-loop recycle system using a charged ultrafiltration membrane to decolorize reactive dye effluents from a textile yarn and fabric dyeing process is described. Two changes were made to conventional reactive dyeing methods to make charged ultrafiltration feasible as a dyebath reuse technique. The electrolyte concentration was rationalized and pH control was achieved using only sodium hydroxide. The economics of the process depend on the value of the electrolyte ($5 to $10 per cu m). Conventional reactive dyeing technology was examined in terms of electrolyte rejection, color rejection and permeate flux under varying conditions of solution pH, ionic strength, and operating pressure. Color rejection required at 0% water recovery to achieve a normalized composite permeate color quality of 0.01 is plotted as a function of the water recovery. Color rejection improves as the trans-membrane pressure is increased. The operating temperature has no effect on the color or salt rejection. The permeate flux increased rapidly with temperature. The membrane tested had a temperature limitation of 45 C, and a full-scale plant would be designed to operate at this temperature. Although little or no dye precipitation occurs on the membrane surface, membrane cleaning is required for a colloid slime observed on the flat sheet membrane to avoid a reversible flux decline. The commercial charged ultrafiltration membrane could not be used above pH 10 and so the dyebath pH was reduced to pH 7 before ultrafiltration. Based on a conservative design flux of 10 L/sq m/hr, the plant should recoup the capital outlay in under three years. The mass of electrolytes discharged to the environment will be reduced by more than 90%. (Geiger-PTT)
W89-06500

DETAILED INVESTIGATION OF EFFECTS OF OPERATING PARAMETERS OF ULTRAFILTRATION USING LABORATORY-SCALE ULTRAFILTRATION UNIT,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Vigneswaran, and W. Y. Kiat.
Desalination DSLNAH, Vol. 70, No. 1-3, p 299-316, November 1988. 11 fig, 1 tab, 2 ref.

Descriptors: *Wastewater treatment, *Water treatment, *Ultrafiltration, *Membrane processes, Performance evaluations, Filters, Flow velocity, Mathematical models, Design criteria, Separation techniques.

Cross-flow filtration techniques like ultrafiltration and microfiltration are useful for removing macromolecules, colloids, and suspended solids in water and wastewater treatment. Cross flow ultrafiltration is a pressure driven membrane process in which the fluid to be filtered flows parallel to the membrane surface. The formation of filter cake can be reduced by scouring force of the flow, thus better permeate rate is obtained. Laboratory-scale ultrafiltration experiments with polyvinyl alcohol (PVA) solution of known molecular weight were carried out to study the membrane filter performances with respect to operating parameters. These operating parameters included: membrane molecular weight cutoff size, molecular weight of PVA, influent concentration, cross flow velocity and applied pressure. It was discovered that clogging in the membrane occurs quite slowly during the first 30 minutes, and quasi-steady state was noticed normally after 50 minutes of filtration time. In this study, steady state flux data were used to develop semi-empirical and empirical correlations which are useful in the optimum design of ultrafiltration. (Author's abstract)
W89-06501

PILOT INVESTIGATION ON THE TREATMENT OF FERTILIZER MANUFACTURING PROCESS EFFLUENT USING LIME AND ELECTRODIALYSIS REVERSAL,
Council for Scientific and Industrial Research, Pretoria (South Africa).
J. J. Schoeman, I. J. M. Buys, I. B. Schutte, and H. Macleod.
Desalination DSLNAH, Vol. 70, No. 1-3, p 407-429, November 1988. 12 fig, 4 tab, 14 ref.

Descriptors: *Industrial wastes, *Electrodialysis, *Phosphorus removal, *Wastewater treatment, *Lime, *Fertilizers, Phosphates, Nutrients, Capital costs, Brines, Industrial wastes, Flocculation, Separation techniques, South Africa, Dissolved solids.

The treatment of a fertilizer company's effluent was evaluated using lime and electrodialysis reversal (EDR) for phosphate removal, water and chemical recovery, and effluent volume reduction. Phosphate could be reduced from 3800 to less than 50 mg/L at pH 8.5 with lime; however, phosphate removal from the lime treated effluent using EDR was poor (75% removal). The EDR product water complied with the requirements for cooling tower make-up except for total dissolved solids and phosphates. However, the required specifications should be met using 10 stage EDR. In addition, plant nutrients (NH4(+), NO3(-)) may be recovered from the brine, which comprised 20% of the initial effluent volume. Membrane scaling was virtually absent. A full scale EDR plant should run well with electrical adjustments and/or frequent acid cleaning. Electrical energy consumption for EDR treatment was found to be 4.5 kWh/cu m feed (pumping costs excluded). The capital cost for a 30 cu m/hr EDR plant and clarifloculator (PO4 removal) was estimated at US$750,000. (Author's abstract)
W89-06502

REMOVAL OF SULPHURIC ACID FROM NATURAL AND INDUSTRIAL WASTE WATERS,
Natal Univ., Durban (South Africa). Dept. of Chemical Engineering.
A. E. Simpson, and C. A. Buckley.
Desalination DSLNAH, Vol. 70, No. 1-3, p 431-442, November 1988. 10 fig, 4 tab, 4 ref.

Descriptors: *Acid mine drainage, *Wastewater treatment, *Separation techniques, *Sulfuric acid, *Industrial wastes, *Membrane processes, *Electrolysis, Electrolytes, Lime, Dissolved solids, Anions, Sulfates, Chemical precipitation, Demineralization, Chemical potential.

A process is described which enables the removal of sulfuric acid from effluents without the addition of chemicals to the effluent. The technique employs an anion selective membrane which separates the acidic effluent from a lime solution. In the case where no current is applied, facilitated transport occurs and the driving force for the demineralization process is the difference in the chemical potential of the species on either side of the membrane. The equilibrium position may be shifted by the passage of a current through the membrane, in which instance the driving force becomes the applied electric potential. The sulfates are removed as calcium sulfate, which precipitates in the lime solution. The specific membrane area requirements are a function of the desired degree of acid reduction. The application of low current densities (500 A/sq m) reduces the specific membrane area requirements for a particular duty by two orders of magnitude compared to facilitated transport. Results of laboratory investigations are given and indicate that the sulfuric acid component can be removed from waste waters without an undesirable build-up of additional dissolved solids. (Author's abstract)
W89-06503

REDUCTIVE DECHLORINATION OF POLYCHLORINATED BIPHENYLS BY ANAEROBIC MICROORGANISMS FROM SEDIMENTS,
Michigan State Univ., East Lansing. Dept. of Crop and Soil Sciences.
J. F. Quensen, J. M. Tiedje, and S. A. Boyd.
Science SCIEAS, Vol. 242, No. 4879, p 752-754, November 4, 1988. 2 fig, 1 tab, 23 ref.

Descriptors: *Fate of pollutants, *Biotransformation, *Polychlorinated biphenyls, *Sediments, *Anaerobic bacteria, Chemical reduction, Chemical reactions, Bacteria, Hudson River, Aroclors, Molecular structure, Biological treatment, Fate of pollutants, Gastropods, Structure-activity relationships.

Microorganisms from Hudson River sediments reductively dechlorinated most polychlorinated biphenyls (PCBs) in Aroclor 1242 under anaerobic conditions, thus demonstrating PCB dechlorination by anaerobic bacteria in the laboratory. The most rapid dechlorination was observed at the highest PCB concentration used; at 700 ppm Aroclor, 53% of the total chlorine was removed in 16 weeks, and the proportion of monochlorobiphenyls and dichlorobiphenyls increased from 9 to 88%. Dechlorination occurred primarily from the meta and para positions; congeners that were substituted only in the ortho position (or positions) accumulated. These dechlorination products are both less toxic and more readily degraded by aerobic bacteria. These results indicate that reductive dechlorination may be an important environmental fate of PCBs, and suggest that a sequential anaerobic-aerobic biological treatment system for PCBs may be feasible. (Author's abstract)
W89-06529

FLUID BED TECHNOLOGY FOR SLUDGE DESTRUCTION,
CWC-HDR, Inc., Edmonds, WA.
For primary bibliographic entry see Field 5E.
W89-06548

SHOULD WATER DISTRICT TREATMENT PLANTS BE REGIONALIZED,
A. S. Griffith, and E. J. Rhomberg.
Public Works PUWOAH, Vol. 119, No. 13, p 36-39, December 1988. 3 tab, 4 ref.

Descriptors: *Water districts, *Regional planning, *Wastewater facilities, *Houston, Texas, *Economic aspects, *Public policy, Inspection, Enforcement, Costs, Flow measurement, Operating policies, Infiltration.

Water district treatment plants in Harris County, TX, surrounding the city of Houston, were investigated, primarily to determine whether alternatives to the proliferation of small local plants might improve the management of wastewater treatment facilities. Data were obtained from the Texas Water Commission (TWC) annual inspection reports and self-reports submitted to the TWC. Many districts were found to be having problems with infiltration and inflow, and with flow measurement of effluent. An evaluation of operating and maintenance costs revealed that costs are much lower as plant capacity and loading increase, thus demonstrating that large regional plants operate more efficiently. The City of Houston has approved a resolution calling for the adoption of a regionalization plan that would provide for wastewater treatment in developing areas through construction of an optimum number of large plants, each serving an area of the community within Harris County. Newly created water districts would be required to share capital costs for the construction of the plants and their collection systems. The plan would halt the proliferation of small plants, reducing costs and increasing efficiency. (Doria-PTT)
W89-06552

REMOVAL OF LOW LEVELS OF MERCURY FROM AQUEOUS SOLUTIONS,
Oak Ridge Y-12 Plant, TN.
J. M. Napier.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-001820. Price codes: A03 in paper copy, A01 in microfiche. Report No. Y/DZ--255/R1, 1987. 12p, 9 fig. DOE Contract DE-AC05-84OR21400.

Descriptors: *Wastewater treatment, *Mercury, Water storage, Ion exchange, Chemical treatment, Reverse osmosis, Ferrous sulfide, Distillation, Resins, Process water.

Water line breaks occurred in an obsolete process building which formerly used mercury as one of the process fluids. About 1 1/2 million gallons of water were collected. Some of it was stored in tanks and some stored in a concrete-lined subbasement of the building. The stored water was contaminated with more than 100 micrograms/L (ppb) of mercury since the floors of the building were previously contaminated with mercury. A process to remove the mercury to less than 2 ppb and discharge the water to the environment was required. Several conventional processes were examined which included ion-exchange resins, reverse osmosis, distillation, and found to be ineffective. A process was developed using ferrous sulfide loaded on ion-exchange resins. The water emitted from the modified ion-exchange resin was typically < 1 ppb with most of the process water containing < 0.5 ppb. (Author's abstract)
W89-06661

PILOT SCALE TREATMENT OF AQUEOUS METAL AND CYANIDE BEARING HAZARDOUS WASTES,
Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
S. Q. Hassan, J. E. Park, and M. K. Koczwara.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-134085. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/355, November 1987. 16p, 2 fig, 5 tab, 9 ref.

Descriptors: *Waste treatment, *Hazardous materials, *Hazardous wastes, *Metals, *Cyanide, Pilot plants, Chemical precipitation, Ion exchange, Nickel, Copper, Flocculation, Chemical treatment.

The U.S. EPA has been directed to evaluate the performance of various technologies for the treatment and/or destruction of certain wastes that are presently being disposed of in landfills and surface impoundments. As a part of the EPA alternative technologies research program, existing treatment technologies that are applicable to metal and cyanide bearing hazardous wastes are being tested. The units which have been designed and fabricated for testing are: lime precipitation, sulfide precipitation, mixed-media filtration, ion exchange and alkaline chlorination of cyanide. As a result of the phase I testing, it was determined that addition of ferrous sulfide and polyelectrolytic flocculant in the precipitation/clarification step enhanced the effluent quality. Nickel and copper were difficult to remove as a result of possible complex formations with chelating agents. Ion exchange polishing markedly improved the effluent quality while mixed-media filtration provided little treatment enhancement. (Lantz-PTT)
W89-06665

AEROBIC AND ANAEROBIC MICROBIAL DISSOLUTION OF TOXIC METALS FROM COAL RESIDUES,
Brookhaven National Lab., Upton, NY. Dept. of Applied Science.
A. J. Francis, C. J. Dodge, and C. R. Krishna.
Available from National Technical Information Service, Springfield, VA 22161, as DE87-014284. Price codes: A02 in paper copy, A01 in microfiche. Report No. BNL--40141, July 1987. 7p, 2 fig. DOE Contract DE-AC02-76CH00016.

Descriptors: *Microbial weathering, *Path of pollutants, *Aerobic processes, *Anaerobic processes, *Metals, *Mine wastes, Trace metals, Iron compounds, Nutrients, Bacteria, Pyrite, Oxides.

Microbial dissolution of toxic metals from coal residues was studied under aerobic and anaerobic conditions. Aerobically, native autotrophic bacteria solubilized varying amounts of As, Cr, Cu, Mn, Ni, Pb and Zn. Dissolution of the above metals was increased by several-fold when inorganic nutrients N and P were supplemented. Under anaerobic conditions native anaerobic bacteria solubilized significant amounts of Fe, Cr, and Mn when amended with carbon and nitrogen. Selective chemical extraction analyses of coal residues indicate the association of most trace metals with pyrite, Fe-oxide, and a soluble phase, possibly ferric sulfate. These results indicate that the predominant mechanism of microbial dissolution of metals from coal residues under aerobic conditions is direct bacterial oxidation of pyrite and acid production; under anaerobic conditions is due to direct bacterial reduction of iron and manganese

oxides and release of trace metals coprecipitated with the oxides. (Author's abstract)
W89-06671

GUIDELINES FOR INSTITUTIONAL ASSESSMENT: WATER AND WASTEWATER INSTITUTIONS,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 6E.
W89-06678

CHEMICAL AND BIOLOGICAL CHARACTERIZATION OF MUNICIPAL SLUDGES, SEDIMENTS, DREDGE SPOILS, AND DRILLING MUDS.
American Society for Testing and Materials, Philadelphia, PA. ASTM Special Technical Publication 976. 1988. 512p. Edited by James J. Lichtenberg, John A. Winter, Cornelius I. Weber and Larry Fradkin.

Descriptors: *Symposium, *Sludge, *Sediments, *Drilling fluids, *Spoil banks, *Sampling, *Pollutant identification, *Chemical analysis, *Bioassay, Risks, Wastewater analysis, Organic compounds, Inorganic compounds, Standards, Preservation.

This publication contains papers presented at the Symposium on Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds, held in Cincinnati, Ohio, on 20-22 May 1986. The aim of the meeting was to determine the state of the art in sampling and analytical methods for sludges and other solids. Included articles cover the following areas: sludge and risk assessment; regulations related to sewage sludge disposal, sediment quality, and analytical methodology; methods for chemical characterization of sediments, sludges, and waste streams; biological characterization of sewage, sludges, and sediments; and methods of risk assessment. It was apparent from the symposium presentations that limited data are available on analytical methods for metals, inorganic and organic chemicals, and biological agents in municipal sludges and other solids. Standardized and validated methods are needed for application to these matrices. Too little work has been done to standardize procedures for sampling and preservation of sludges. Current techniques and holding times must be reviewed and evaluated, particularly those for organic analytes in biologically active systems. (See W89-06706 thru W89-06747) (Rochester-PTT)
W89-06705

SLUDGE AND RISK ASSESSMENT,
Environmental Protection Agency, Washington, DC. Office of Research and Development.
For primary bibliographic entry see Field 5A.
W89-06706

U.S. SLUDGE MANAGEMENT GUIDELINES EXPLAINED,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5E.
W89-06707

DISTRIBUTION OF HEAVY METALS IN SEWAGE SLUDGE: THE EFFECT OF PARTICLE SIZE,
Water Research Centre, Medmenham (England). Medmenham Lab.
For primary bibliographic entry see Field 5A.
W89-06716

PERSPECTIVE ON RISK OF WATERBORNE ENTERIC VIRUS INFECTIONS,
Epidemiology Research Center, Tampa, FL. Dept. of Health and Rehabilitative Services.
For primary bibliographic entry see Field 5E.
W89-06729

ROUND ROBIN TESTING OF METHODS FOR THE RECOVERY OF HUMAN ENTEROVIRUSES FROM WASTEWATER SLUDGES AND SEWAGE AMENDED SOILS: ASTM CONSENSUS STANDARDS DEVELOPMENT,
Army Biomedical Research and Development Lab., Fort Detrick, MD.
For primary bibliographic entry see Field 5A.
W89-06730

THERMAL INACTIVATION OF HUMAN ENTERIC VIRUSES IN SEWAGE SLUDGE AND VIRUS DETECTION BY NITROSE CELLULOSE-ENZYME IMMUNOASSAY,
Hawaii Univ., Honolulu. Dept. of Microbiology.
P. C. Loh, R. S. Fujioka, and W. M. Hirano.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 273-281, 2 fig, 7 tab, 6 ref.

Descriptors: *Wastewater treatment, *Enteroviruses, *Wastewater analysis, *Sludge, *Bacteria, *Heat treatment, Zimpro Process, Hawaii, Pollutant identification, Immunoassay, Enzymes, Infectivity, Performance evaluation.

The Zimpro Thermal Sludge Treatment Process installed at the Sand Island Wastewater Treatment Plant, Honolulu, Hawaii, was evaluated for its reliability in disinfecting human enteric viruses and fecal bacteria in treated sludge. The principle of this process involves grinding the sludge particles to a small size (< 4.8 mm) and heating the ground sludge to 193 C under 330 psi pressure for 30 min. Such thermally treated sludge yielded no human enteric viruses and little or no fecal bacteria (< 2-24 MPN/100 g), thus rendering the sludge safe for reuse. In corollary studies, the nitrocellulose-enzyme immunoassay was evaluated as an alternate cost-effective method to augment infectivity assays for the detection of human enteric viruses. The method was rapid, highly sensitive (capable of detecting of picogram quantities), and specific for the detection of human enteric viruses. (See also W89-06705) (Author's abstract)
W89-06731

RECOVERY OF NATURALLY OCCURRING ROTAVIRUSES DURING SEWAGE TREATMENT,
Baylor Coll. of Medicine, Houston, TX. Dept. of Virology and Epidemiology.
For primary bibliographic entry see Field 5A.
W89-06732

MUTAGENIC POTENTIAL OF MUNICIPAL SEWAGE SLUDGE AND SLUDGE AMENDED SOIL,
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
K. C. Donnelly, K. W. Brown, and C. P. Chisum.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 288-299, 5 fig, 3 tab, 36 ref. EPA Grant CR-812037-01-0.

Descriptors: *Mutagens, *Carcinogens, *Wastewater treatment, *Municipal wastes, Sludge, Soil analysis, Land application, Soil amendments, Salmonella/microsome assay, Comparison studies, Industrial wastes, Pollutant identification, Wastewater analysis.

Twelve municipal wastewater treatment plant sludges were collected and extracted by sequential extraction with methylene chloride and methanol on a Soxhlet apparatus. Each of three sludge fractions, methylene, chloride, methanol, and a combined fraction (36 fractions total) was tested in the Salmonella/microsome assay. Only one of the sludge fractions induced a positive response in the absence of metabolic activation, and twelve fractions induced a doubling of revertant colonies at two or more consecutive dose levels with activation. The maximum mutagenic response observed with strain TA98 in a methylene chloride fraction was 120 net revertants at a dose level of 10 mg extract/plate. The maximum response induced by the methanol and combined fractions was 89 net revertants, induced by a municipal sludge with 20% industrial contribution, and 61 net revertants, induced by a municipal sludge with 19% industrial contribution, respectively, both of which were tested with strain TA98 at a dose level of 5 mg extract/plate. These results indicate that there will be substantial differences in the mutagenic potential of municipal sludges from a single source and from different sources. The results of a land application study using one of these sludges indicates that some of these mutagenic compounds may be persistent in the soil. (See also W89-06705) (Author's abstract)
W89-06733

ANAEROBIC DEGRADATION, PROCESSES AND TEST METHODS,
Agricultural Univ., Wageningen (Netherlands). Dept. of Microbiology.
For primary bibliographic entry see Field 5B.
W89-06778

MASS FLUXES OF LINEAR ALKYLBENZENESULPHONATES, NONYLPHENOL, NONYLPHENOL MONO- AND DIETHOXYLATE THROUGH A SEWAGE TREATMENT PLANT,
Venice Univ. (Italy). Dept. of Environmental Science.
A. Marcomini, S. Capri, P. H. Brunner, and W. Giger.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 266-277. 5 fig, 3 tab, 24 ref.

Descriptors: *Wastewater treatment, *Raw wastewater, *Effluents, *Pollutant identification, *Alkylbenzenesulfonates, *Mass transfer, Biodegradation, Primary wastewater treatement, Secondary wastewater treatment, Sludge digestion, Digestion, Anaerobic conditions.

Dissolved and particulate LAS, NP, N1PEO and NP2EO were determined in raw sewage, primary effluent, secondary effluent, primary and secondary sludge of the sewage treatment plant Zurich-Glatt on two consecutive sampling days. The results were combined with sewage flow rate and dry matter load measurements in order to obtain the respective mass fluxes. The latter provided information on the major removal processes affecting these detergent derived chemicals, i.e. biodegradation during activated sludge treatment and incorporation into sludge. The overall removals of LAS over the two sampling days were 99.3% and 98.7% (w/w), of which 13% and 16%, respectively, were found in raw sludge and 9% and 13%, respectively, in anaerobically digested sludge. Both NP1EO and NP2EO were poorly removed in the secondary effluent and were educts for NP in sludge. Nonylphenol loads in the anaerobically digested sludge were 4.7 and 6.4 times larger than in the raw sewage. (See also W89-06748) (Author's abstract)
W89-06783

MUTAGENIC COMPOUNDS IN CHLORINATED WATERS,
Abo Akademi, Turku (Finland). Lab. of Forest Products Chemistry.
B. Holmbom, L. Kronberg, and A. Akademi.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 278-283. 4 fig, 2 tab, 28 ref.

Descriptors: *Water treatment, *Wastewater treatment, *Pulp wastes, *Chlorination, *Humic acids, *Mutagenicity, *Water pollution effects, *Drinking water, Chemical properties, Sulfites, Molecular structure.

Chlorination of lignin and humic material in water produces the strong bacterial mutagen 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone or its acyclic form Z-2-chloro-3-(dichloromethyl)-4-oxobutenoic acid ('MX'), and its geometric E-isomer

('E-MX'). Although MX is a trace component in the mixture of chlorination products, it is the main single contributor to the Ames mutagenicity in wood pulp chlorination liquors as well as in chlorinated drinking waters. Higher mutagenicity and higher amounts of MX and E-MX are produced during chlorination under acidic conditions than under neutral conditions. Substitution of chlorine by chlorine dioxide decreases the formation of mutagens. Although E-MX has a much lower mutagenicity than MX, the compound is of concern since it can be isomerized to MX. This conversion occurs particularly under acidic conditions. MX reacts with sulfite and sulfide. Sulfite treatment may be a feasible process to remove chlorinated mutagens from both bleaching waters and drinking waters. (See also W89-06748) (Author's abstract)
W89-06784

RESEARCH AND BEHAVIOR OF ORGANIC MICROPOLLUTANTS FROM WASTE DISTILLERY WINE IN ANAEROBIC TREATMENT,
Confederacion Hidrografica del Guadiana, Mopu, Spain.
R. Sanchez Crespo, and J. Prada Alvarez-Buylla.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 323-328. 3 fig, 1 tab.

Descriptors: *Anaerobic digestion, *Wastewater treatment, *Industrial waste, *Distillery wastes, Organic wastes, Organic compounds, Fermentation, Chemical properties, Flocculation, Sedimentation, Spain.

The industrial waste from the extraction of ethanol from wine and its sub-products constitutes a serious problem of contamination for the continental waters of Spain where the waste is dumped. The results obtained from an investigation into the organic micropollutants in this waste, their evolution and behavior in a process of purifying through accelerated anaerobic fermentation are presented. The purification process includes neutralization with lime, flocculation, sedimentation, centrifugation, natural evaporation in a lagoon, and accelerated anaerobic digestion. The results show a high degree of purification that reaches, for some standard parameters, more than 95%, and for the overall total of the micropollutants, reaches values of 99.9%. (See also W89-06748) (Friedmann-PTT)
W89-06789

INFLUENCE OF WASTE WATER DISINFECTION TREATMENTS ON SOME GENOTOXIC CHEMICAL MICROPOLLUTANTS,
Perugia Univ. (Italy).
A. Savino, R. Pasquini, R. Conti, C. Melchiorri, and A. Di Caro.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 357-369. 6 fig, 4 tab, 27 ref.

Descriptors: *Disinfection, *Wastewater treatment, *Urban wastes, *Industrial wastes, *Sewage, Sedimentation, Chlorination, *Biological wastewater treatment, *Activated sludge process, Biodegradation, Mutagenicity, Hydrocarbons, Ozonation, Viricides, Bactericides, Trihalomethanes.

The effects of different waste water treatments using sodium hypochlorite, chlorine dioxide and ozone on some chemical and biological parameters were compared. The samples studied were obtained from an activated sludge treatment plant for the urban effluents of a large city and from a mixed urban and industrial waste sewage (treated only by sedimentation). A bacterial mutagenicity test (Ames test), microbiological examinations (coliforms, fecal streptococci and coliphages), determinations of the principal chemical parameters and of some organic micropollutants (polycyclic aromatic hydrocarbons PAH, and volatile haloderivatives VHO) were carried out on the effluents both before and after disinfection. The results showed that all treated and untreated samples were not mutagenic and that only ozone was able to reduce the concentration of all the examined organic micropollutants. Treatment with hypochlorite decreased only PAH concentration, even though their halogenated derivatives and trihalomethanes were formed. Trihalomethanes were found generally in lower concentrations after disinfections with chlorine dioxide. Hypochlorite showed a good bactericidal activity, but little viricidal activity, whereas chlorine dioxide and ozone showed very good disinfectant activity on both bacterial and viral forms. (See also W89-06748) (Author's abstract)
W89-06795

TREATMENT AND USE OF SEWAGE EFFLUENT FOR IRRIGATION.
Proceedings of the FAO Regional Seminar on the treatment and use of sewage effluent for irrigation held in Nicosia, Cyprus, 7-9 October 1985. Butterworths, London. 1988. 388p. Edited by M.B. Pescod and A. Arar.

Descriptors: *Fertilization, *Wastewater irrigation, *Wastewater treatment, *Wastewater disposal, *Wastewater composition, *Agriculture, *Land disposal, *Water reuse, Irrigation programs, Irrigation water, Fate of pollutants, Path of pollutants, Planning, Europe, Middle East, Public health.

The purpose of the Seminar was to review available information and experience on the treatment and reuse of sewage effluent for increased agricultural production. The papers were presented by international experts on health and agricultural guidelines for effluent quality and on the short-term and long-term effects of effluent reuse on public health, soil fertility and crop productivity. Appropriate sewage treatment systems are considered and sewage sludge treatment and agricultural utilization are discussed. Case studies of sewage effluent treatment and reuse in irrigation in West Germany, Asia and the Pacific, Egypt, Cyprus, Mexico, Jordan, Saudi Arabia, Kuwait, Syria, Portugal, and France are presented. In addition, recommendations for national policies, project guidelines, and the development of low-cost technologies are discussed. (See W89-06802 thru W89-06826) (White-Reimer-PTT) (Author's abstract)
W89-06801

BACKGROUND TO TREATMENT AND USE OF SEWAGE EFFLUENT,
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
A. Arar.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 10-17, 1 fig, 11 ref.

Descriptors: *Wastewater irrigation, *Wastewater disposal, *Land disposal, *Wastewater treatment, *Water reuse, Irrigation water, Fate of pollutants, Path of pollutants, Hydrogen ion concentration, Oxidation, Planning, Public health, Population exposure, Municipal wastewater, Heavy metals, Crop production.

Sewage irrigation ensures the reuse of resources and achieves the best treatment of municipal wastewater. It was concluded that efforts should be focused on maximizing the benefits and on minimizing any detrimental effects to the environment and to man himself. Precautions to control adverse effects include: (1) maintaining soil pH at or above 7.0 to lower the availability of most heavy metals, (2) maintain low oxidation potential, (3) grow crops which exclude particular heavy metals from the whole plant or from the reproductive tissues, (3) grow non-edible crops, (4) use low annual application rates, (5) control sewage irrigation, (6) maintain the organic matter status of the soil. Since sewage irrigation involves complex interactions and it is difficult to assess its long-term impact, appropriate management and monitoring is essential. (See also W89-06801) (White-Reimer-PTT)
W89-06802

WASTE STABILIZATION PONDS: THE PRODUCTION OF HIGH QUALITY EFFLUENTS FOR CROP IRRIGATION,
Leeds Univ. (England). Dept. of Civil Engineering.
D. Mara.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 87-92, 1 tab, 11 ref.

Descriptors: *Stabilization ponds, *Water quality, *Crop production, *Wastewater treatment, *Wastewater disposal, *Water reuse, *Wastewater irrigation, *Effluents, Anaerobic ponds, Facultative ponds, Maturation ponds, Pathogens, Stabilization lagoons, Coliforms, Biochemical oxygen demand, Brazil, Egypt, Shock loads, Design criteria, Wastewater lagoons.

Three types of ponds are usually arranged in the following sequence to form series of ponds capable of treating any biodegradable wastewater to any required quality standard: anaerobic ponds in which the suspended solids settle to the bottom and undergo anaerobic digestion; facultative ponds with a lower anaerobic zone and an upper aerobic zone; and maturation ponds where the number of excreted pathogens and nutrients are reduced to the desired level. Stabilization ponds are usually the least expensive form of treatment, capable of reducing the concentration of excreted pathogens to very low levels, capable of absorbing hydraulic and organic shock loads, tolerant of high concentrations of heavy metals, and easy to operate. Pond design procedures are presented using an empirical approach based on volumetric BOD5 loading for anaerobic ponds, a modification of the McGarry and Pescod's equation for facultative ponds, and fecal coliform removal efficiencies for maturation ponds. A series of five ponds in Brazil performed efficiently and economically. Plans are being developed for using waste stabilization ponds in Alexandria, Egypt in order to conserve water and develop more agricultural areas. (See also W89-06801) (White-Reimer-PTT)
W89-06807

DESIGN, OPERATION AND MAINTENANCE OF WASTEWATER STABILIZATION PONDS,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
M. B. Pescod, and D. D. Mara.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 93-115, 2 tab, 7 fig, 22 ref.

Descriptors: *Design criteria, *Wastewater treatment, *Wastewater renovation, *Stabilization ponds, Anaerobic ponds, Facultative ponds, Maturation ponds, Design, Costs, Biochemical oxygen demand, Algae, Macrophytes, Wastewater lagoons, Wastewater disposal, Fish ponds, Maintenance, Monitoring.

Pond systems are designed in series to achieve up to three stages of treatment. The number of stages used depends on the organic strength of the input waste and the effluent quality objectives. Anaerobic ponds are very cost-effective for the removal of BOD, when it is present in high concentration. Facultative ponds with both an aerobic and anaerobic layer treat the anaerobic pond effluent followed by maturation ponds if effluents with less than 50 mg/L BOD5 are required. Aerated lagoons, high-rate aerobic ponds, and macrophyte ponds can be designed for specialized uses. In some cases fish are used to harvest algae from high-rate aerated ponds in order to provide a needed source of protein, particularly in developing countries. The design of stabilization ponds must consider site suitability, embankment and pond inlet/outlet structures, pond lining, and associated structures such as fencing. Pond systems should be established during the hottest period of the year in order to quickly establish the necessary microbial populations. Although maintenance requirements are simple, they must be carried out regularly to prevent odor and pest nuisances. Once the pond system has been established, a routine monitoring and evaluation program is necessary to determine performance and effluent quality. The economic

feasibility of pond systems is dependent on land values. (See also W89-06801) (White-Reimer-PTT)
W89-06808

GROUNDWATER RECHARGE AS A TREATMENT OF SEWAGE EFFLUENT FOR UNRESTRICTED IRRIGATION,
Agricultural Research Service, Phoenix, AZ. Water Conservation Lab.
H. Bouwer.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 116-128, 3 tab, 2 fig, 14 ref.

Descriptors: *Wastewater treatment, *Reclaimed water, *Wastewater renovation, *Groundwater, *Groundwater recharge, *Groundwater irrigation, Vadose water, Soil-aquifer treatment, Water quality, Arizona, Infiltration, Feasibility studies, Economic aspects.

The chemical quality requirements for using sewage effluent for irrigation are the same as those for regular irrigation water. Where hydrogeological conditions are favorable for groundwater recharge with infiltration basins, the necessary treatment can be obtained very simply by the filtration process as the sewage percolates through the soil and the vadose zone, down to the groundwater and then some distance through the aquifer. This 'soil-aquifer treatment' (SAT) process removes essentially all suspended solids, micro-organisms and phosphorus, and significantly reduces the concentrations of nitrogen and heavy metals. The feasibility of the SAT process was studied with two experimental systems in Phoenix, Arizona. For both projects, most of the quality improvement of the wastewater occurred in the vadose zone (between soil surface and groundwater table). The results showed the renovated water from the projects meets the public health, agronomic and aesthetic requirements for unrestricted irrigation, including vegetable crops that are consumed raw, as well as primary contact recreation standards. The costs are relatively low and the systems do not require highly trained operators, thus, it is a viable alternative where land availability and hydrogeological conditions are favorable. (See also W89-06801) (White-Reimer-PTT)
W89-06809

UK EXPERIENCE IN THE GROUNDWATER RECHARGE OF PARTIALLY TREATED SEWAGE: POTENTIAL FOR IRRIGATION PURPOSES,
H. A. C. Montgomery.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 129-135, 1 fig, 16 ref.

Descriptors: *Wales, *Wastewater treatment, *Groundwater recharge, *Groundwater irrigation, *Water reuse, *Reclaimed water, *Wastewater irrigation, *Wastewater disposal, *Wastewater renovation, *England, Water quality, Nutrients, Heavy metals, Aquifer characteristics, Nitrogen removal, Phosphorus removal.

Effects of groundwater recharge were studied at nine sites in England at chalk, Triassic sandstone and alluvial gravel sites. The results showed that artificial recharge is a remarkably effective method of removing organic matter, ammonia, bacteria and viruses. Whether nitrogen removal should be encouraged or not at recharge sites depends on (a) how much of the nitrogen content of the sewage is required as a crop nutrient during irrigation; and (b) whether the water is also to be used for potable supply. Phosphate is removed by recharge into calcareous rocks. Iron and manganese are deficient in sewage effluent and might have to be supplemented in some soils. Toxic heavy metals tend to be associated with the suspended solids of sewage and would not be recharged (unless solubilized by anaerobic action). Calcium, magnesium, sodium, chloride and sulfate all tend to be conserved during artificial recharge and could restrict the use of recharged effluent for irrigation in arid climates. The method of applying the effluent to the recharge area needs to be selected based on the effluent type, climate, and soil conditions. Any site being considered for the recharge of sewage effluent should be investigated geologically. (See also W89-06801) (White-Reimer-PTT)
W89-06810

SOIL-AQUIFER TREATMENT AND REUSE OF SEWAGE EFFLUENT: A NEW APPROACH TO SANITATION,
BURGEAP S.A., Paris (France).
J. Bize, D. Fougeirol, V. Riou, and N. Nivault.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 136-151, 5 tab, 6 fig.

Descriptors: *Soil treatment, *Aquifers, *Wastewater treatment, *Wastewater disposal, *Wastewater renovation, *Water reuse, *Land disposal, *Wastewater irrigation, *Irrigation, *Sanitation, Public health, Soil-aquifer treatment, Biological wastewater treatment, France, Disinfection, Aeration, Pathogens, Costs.

The reuse of sewage effluent for irrigation is often carried out under deplorable sanitary conditions which need to be improved, especially in the area of sewage disinfection. Because classical waste treatment systems do not adequately solve this problem, the soil-aquifer treatment (SAT) using fixed bacteria for biological purification was developed. SAT uses mineral granular media with large specific surface with sufficiently large pores to encourage bacteria to settle, requires the permanent presence of a high concentration of bacteria, and continuous aeration to ensure sufficient oxygen for bacterial metabolism (except for anaerobic processes such as denitrification). Despite difficulties in selecting a hydraulic supply for running and washing processes, the risk of eliminating too much sludge and creating low activity for the next cycle in the washing process, and the presence of mud in the system increasing loss of load in the system; fixed-bacteria purification processes are highly effective. Two sites in France were examined to evaluate the system. The Port Leucate development site required an investment cost of $100,000 and an operating cost of $1 per year/inhabitant with pathogen removal greater than for any other disinfection technique. The Flesselles site required an investment of $73,000 and an operating cost of $1 per user/year. It was concluded that in order to reach a very high level of purification and disinfection at Flesselles the thickness of the sand would have to be increased to 1.5 m. However, the treatment plant could then be eliminated. (See also W89-06801) (White-Reimer-PTT)
W89-06811

MANAGING THE SEWAGE SLUDGE COMPOSTING PROCESS,
Agricultural Research Service, Beltsville, MD. Soil-Microbial System Lab.
G. B. Willson.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 152-163, 3 tab, 5 fig, 25 ref.

Descriptors: *Sludge management, *Wastewater treatment, *Composting, *Sludge disposal, *Sludge utilization, *Sludge conditioning, *Land disposal, Fertilizers, Bulking sludge, Aeration, Soil contamination, Marketing.

The stability, or conversely the digestibility, of the sludge determines the potential for self-heating and composting with the volatile solids content of the sludge providing a rough indication of its stability. The primary objective of the bulking material, which is added to the sludge to condition it for composting, is to impart a suitable porosity, texture, structure and moisture content to the sludge to support aerobic microbial activity. Natural or forced aeration of a compost pile supplies oxygen to the micro-organisms and removes excess heat, water vapor, carbon dioxide, ammonia, and other gaseous products of decomposition. The aerated pile method of composting meets the requirements of pathogen destruction and odor control with a minimum of equipment and facilities. A good marketing program for the compost must be based on a knowledge of the characteristics of the compost and the soils, crops and climates where it will be used. Composts made from sewage sludges that are low in heavy metals and toxic organics can be used safely and beneficially as soil conditioners and fertilizers. (See also W89-06801) (White-Reimer-PTT)
W89-06812

USE OF BIOLOGICALLY TREATED WASTEWATER TOGETHER WITH EXCESS SLUDGE FOR IRRIGATION,
Technische Univ. Braunschweig (Germany, F.R.). Inst. fuer Stadtbauwesen.
For primary bibliographic entry see Field 3C.
W89-06813

STATUS OF WASTEWATER TREATMENT AND AGRICULTURAL REUSE WITH SPECIAL REFERENCE TO INDIAN EXPERIENCE AND RESEARCH AND DEVELOPMENT NEEDS,
National Environmental Engineering Research Inst., Nagpur (India).
G. B. Shende, C. Chakrabarti, R. P. Rai, V. J. Nashikkar, and D. G. Kshirsagar.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 185-209, 18 tab, 2 fig, 18 ref.

Descriptors: *Regional development, *India, *Research priorities, *Wastewater treatment, *Wastewater irrigation, *Wastewater disposal, *Water reuse, *Reclaimed water, *Wastewater renovation, *Irrigation, *Agriculture, *Land disposal, Oxidation ponds, Stabilization ponds, Lagoons, Aerated lagoons, Crop production, Developing countries, Planning, Multiobjective planning, China, Public health.

Wastewater treatment by conventional means is too costly for this region and does not solve their pollution problems. Non-conventional treatment through oxidation/stabilization ponds and/or aerated lagoons followed by land application take care of water pollution problems at low cost and also conserve valuable resources from the wastewater for reuse in agricultural production. The long-term experience of India in this field can provide interim guidelines for land application programs in other countries in the region. The criticism concerning health hazards due to irrigation with untreated wastewater can be lessened by judicious and skillful management of the wastewater-soil-crop system and by restricting the choice of crops for wastewater irrigation. A multilocational two-tier framework for a regional research and development project to establish cost-effective and environmentally safe techniques for wastewater reuse as well as provide guidance and training is proposed. (See also W89-06801) (White-Reimer-PTT)
W89-06814

EGYPTIAN EXPERIENCE IN THE TREATMENT AND USE OF SEWAGE AND SLUDGE IN AGRICULTURE,
Alexandria Univ. (Egypt).
A. S. Abdel-Ghaffar, H. A. El-Attar, and I. H. Elsokkary.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 210-222, 17 tab, 15 ref.

Descriptors: *Wastewater treatment, *Sludge utilization, *Agriculture, *Egypt, *Wastewater irrigation, *Wastewater disposal, *Irrigation, *Water reuse, *Reclaimed water, *Wastewater renovation, *Wastewater pollution, *Land disposal, *Sludge disposal, Sludge, Soil analysis, Soil contamination, Crop production, Alexandria, Cairo, Municipal wastewater, Heavy metals, Soil properties, Salinity.

Information on the use of sewage for irrigating Egyptian soils is limited to a few examples from El-Gabal El-Asfar and Abou Rawash Farms near Cairo. Some changes in soil texture and color due to an increase in organic content were reported, but no salt accumulation was noted. Studies in sandy soils indicated wastewater irrigation could

improve soils and provide needed nutrients, but environmental pollution could be a problem. At Abou Rawash Farm soil pH decreased, total soluble salts remained the same, and Mg and Na increased over time. Investigations carried out with Alexandria wastewater evaluated the influence of wastewater irrigation on grapes, oranges, olives and guavas grown in different soils. Overall, the growth of all plant types increased in all soil types with irrigation. Although sewage sludge has favorable soil conditioning properties, many sludges have considerable quantities of heavy metals (particularly Ni, Cd, Cr, and Hg) that can cause phytotoxicity problems. This uptake depends on variables such as soil texture, cation exchange capacity and pH, the amount of sludge applied, the metal composition of the sludge, and the plant species and variety. The salinity problem associated with Alexandria sewage could be solved by mixing with water from the Nubaria canal. The selection of low uptake or non-edible crops could eliminate the pollution problems. (See also W89-06801) (White-Reimer-PTT)
W89-06815

TREATMENT AND USE OF SEWAGE EFFLUENT FOR AGRICULTURE IN CYPRUS: IMMEDIATE PROSPECTS,
V. D. Krentos.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 223-239, 6 tab, 20 ref.

Descriptors: *Agriculture, *Short-term planning, *Wastewater irrigation, *Wastewater disposal, *Water reuse, *Reclaimed water, *Wastewater renovation, *Irrigation water, *Wastewater treatment, *Cyprus, *Land disposal, Crop production, Public health, Soil contamination, Regional planning, Future planning, Irrigation practices, Water quality standards, Water demand, Economic aspects.

The degree of treatment before application is an important consideration in the planning, design and management of irrigation for effluent use. Depending on the degree of treatment, the process is described as preliminary, primary, secondary and tertiary or advanced with disinfection to remove pathogens following the last treatment step for reuse for irrigation. With the exception of small sewage treatment plants (four are described), it is only recently that urban sewage schemes utilizing wastewater irrigation have been proposed. However, health and soil conservation considerations require guidelines for acceptable levels of dissolved salts and biological standards. Due to projected increases for water demand, the utilization of treated sewage effluent for irrigation has attracted increased research and development interest. Experimental work initiated in 1984 at the Agricultural Research Institute using cotton as a test crop indicated treated sewage effluent was superior to fresh water for irrigation because of the added nutrients. In assessing increasing demands on water supplies in this area, it is estimated that about 6% of the land under irrigation could be irrigated with treated sewage effluents. Considering the high cost of developing surface waters, the economic advantages of using sewage effluent would be considerable. (See also W89-06801) (White-Reimer-PTT)
W89-06816

ONGOING RESEARCH ON THE USE OF TREATED SEWAGE EFFLUENT FOR IRRIGATING INDUSTRIAL AND FODDER CROPS,
Agricultural Research Inst., Nicosia (Cyprus).
For primary bibliographic entry see Field 3C.
W89-06817

TREATED SEWAGE EFFLUENT FOR IRRIGATION IN KUWAIT.
Kuwait Agriculture Affairs and Fish Resources Authority, Safat.
For primary bibliographic entry see Field 3C.
W89-06821

USE OF TREATED SEWAGE EFFLUENT FOR IRRIGATION: CASE STUDY FROM KUWAIT,
Cobham Resource Consultants, Oxford (England).
For primary bibliographic entry see Field 3C.
W89-06822

IRRIGATION OF DAMASCUS PLAIN (THE GHOUTA) WITH POLLUTED WATER FROM THE RIVER BARADA,
Damascus Univ. (Syria). Coll. of Engineering.
For primary bibliographic entry see Field 3C.
W89-06823

STUDY OF METHODOLOGIES REGARDING THE USE OF TREATED WASTEWATER FOR IRRIGATION IN PORTUGAL,
Laboratorio Nacional de Engenharia Civil, Lisbon (Portugal).
For primary bibliographic entry see Field 3C.
W89-06824

MICROBIOLOGICAL TESTING OF SOILS IRRIGATED WITH EFFLUENTS FROM TERTIARY LAGOONING AND SECONDARY TREATMENT,
Societe du Canal de Provence et d'Amenagement de la Region Provencale le Tholonet, Aix-en-Provence (France). Inst. Mediterraneen de l'Eau.
For primary bibliographic entry see Field 5A.
W89-06825

TREATMENT AND USE OF SEWAGE EFFLUENT FOR IRRIGATION IN WESTERN ASIA,
Economic Commission for Western Asia, Baghdad (Iraq). Natural Resources, Science and Technology Div.
C. Ertuna.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 352-366, 4 tab, 1 fig, 12 ref.

Descriptors: *Wastewater treatment, *Wastewater irrigation, *Wastewater renovation, *Water reuse, *Land application, * Middle East, Costs, Safety, Wastewater disposal, Irrigation water, Reclaimed water, Water quality standards, Wastewater facilities, Policy making, Regulations, Recycling, Return flow, Groundwater recharge, Population exposure.

Wastewater reuse has been in practice in the Economic Commission for Western Asia (ECWA) region for a considerable period of time; however, it has been limited in application and only recently have plans been formulated for large-scale development of this non-conventional water source. The most important considerations in wastewater reuse are the cost of treatment and health. Wastewater reuse should be considered when the cost of augmenting water supplies exceeds the cost of treating municipal effluent. In planning for the use of treated wastewater the common minimum requirements should be met in the principal treatment plant, and the standards required for each particular use must be met at the separate plants. Government policies must be established regarding the use of treated effluent. Safeguards and precautions necessary in wastewater reuse include the following: (1) Standards and strict regulations should be followed from the beginning and, if necessary, revised after long-term monitoring of the activities; (2) pipes and other system components carrying freshwater supplies and the treated sewage effluent should be clearly differentiated; (3) municipal and agricultural workers who have to use treated wastewater should be well informed about the particulars of this practice and required to minimize their contact with the treated effluent; (4) industry should be encouraged or, if necessary, pressured to recycle part of its wastewater and to treat the rest to acceptable standards so as to minimize pollution; (5) return flows draining to streams should be strictly monitored because the length of the natural purification process may not be adequate before reabstraction downstream, causing accumulation of salts and undesirable substances; (6) in streamflow augmentation, the treated effluent must meet the established criteria so as not to endanger the health of human and animal life downstream; (7) in groundwater recharge and prevention of saline-water intrusion to an aquifer, treated wastewater should be close to drinking-water standards; and (8) the necessary precautions to be taken in the reuse of treated effluents must be presented to the public through the information media. (See also W89-06801) (White-Reimer-PTT)
W89-06826

THREE-DIMENSIONAL OPTIMIZATIONAL MODEL OF REGIONAL WASTEWATER TREATMENT PLANT SYSTEMS WITH APPLICATION TO THE UPPER PASSAIC RIVER,
Rutgers - The State Univ., New Brunswick, NJ. Graduate Program in Environmental Science.
Y. H. Lin.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704083. Ph.D. Dissertation, 1986. 280p, 54 fig, 39 tab, 112 ref, 4 append.

Descriptors: *Computer models, *Optimization, *Wastewater treatment, *Wastewater facilities, *Regional development, Dynamic programming, Model studies, Solid waste disposal, Cost analysis, Computer programs.

A computer optimization model was developed for planning the optimal size, location, and timing of wastewater treatment facilities for a regional water quality management system. The model is solved with a three-phased heuristic procedure that makes strong use of dynamic programming. The programming divides the planning horizon into subintervals so that the combined cost of the solutions to a static facility location problem in each sub interval is minimized. The programming also determines the optimal expansion schedule for each treatment facility and sewerline and the individual disposal choice of each location in each time period to determine if cheaper alternatives exist. The model assumes that the growth in wastewater flow is represented as a step function over time. This assumption results in some error in the computation of annual operating costs, which could be minimized by using short time periods. The model could be modified and applied to regional solid waste disposal systems by changing the cost functions of the waste treatment system to cost functions for a solid waste incinerator or composting plant system and changing the cost functions of the sewerline to those for solid waste transportation. (Cremmins-AEPCO)
W89-06921

CHLORINATED ORGANICS REMOVAL FROM CONTAMINATED SOIL AND GROUNDWATER BY MICROORGANISMS,
Minnesota Univ., Minneapolis. Graduate School.
For primary bibliographic entry see Field 5G.
W89-06928

WASTEWATER APPLICATION TO SOILS: HYDRAULIC AND NITROGEN CONSIDERATIONS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agronomy.
For primary bibliographic entry see Field 5E.
W89-06933

CHARACTERIZATION OF FLUID FLOW AND WASTEWATER TRANSPORT PROCESSES WITHIN A WISCONSIN-TYPE MOUND,
Purdue Univ., Lafayette, IN.
T. E. White.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8709873. Ph.D. Dissertation, 1986. 306p, 59 fig, 51 tab, 86 ref, 5 append.

Descriptors: *Soil disposal fields, *Infiltration, *Groundwater movement, *Wastewater treatment, *Sand filters, *Groundwater pollution, Filtered wastewater, Water transport, Flow characteristics, Soil absorption capacity, Finite element method, Model studies, Evapotranspiration.

An experimental sand mound was constructed at a dairy farm to evaluate design criteria for application to Indiana soils and to determine the effects of

mound treatment on wastewater characteristics, groundwater quality, and fluid flow under seasonal variations. Findings indicate that the raised soil absorption bed or mound system provides an attractive alternative to conventional system design for severe Indiana soils. The unsaturated-saturated flow field of a complex system can be resolved with a high degree of accuracy using the finite element technique. Current procedures for the design of Wisconsin-type mounds will not always safeguard these systems against seasonal high water tables. Groundwater movement into the experimental mound fill occurred on a seasonal basis and resulted in the development of a seepage face at the toe on several occasions. Modeling of the mound flow field revealed that renovated mound water moves away from the system primarily in the upper soil horizons. This finding suggests that the length of the mound perimeter is important for systems located on slowly permeable soils. Flow within the fill moves vertically below the bed and horizontally at the fill-soil interface under high water table conditions. Evapotranspiration is a major mechanism for dissipation of the applied wastewater. (Cremmins-AEPCO)
W89-06937

EFFICACY OF ULTRAVIOLET DISINFECTION OF SECONDARY MUNICIPAL WASTEWATER,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
G. D. Harris.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704967. Ph.D. Dissertation, 1986. 184p, 37 fig, 22 tab, 108 ref, 9 append.

Descriptors: *Wastewater treatment, *Secondary wastewater treatment, *Disinfection, *Ultraviolet radiation, *Municipal wastewater, Cost analysis, Actinomyces, Microorganisms, Photoreactivation, Bacteria, Viruses.

Secondary municipal wastewater disinfection efficiency was studied in relation to ultraviolet (UV) disinfection reactor design, and the photoreactivation, wastewater quality, and cost effectiveness of UV disinfection. The relative resistances to UV radiation of selected bacterial and viral indicator microorganisms were also studied, along with the effects of photoreactivation on indicator microorganisms. The effectiveness of a potassium ferrioxalate chemical actinometric technique for calculating dose in UV disinfection reactors was evaluated. Photoreactivations of as much as 2.0 and 1.5 log, respectively, were periodically observed for total and fecal coliform groups. Water quality parameters found to be significantly correlated to bacterial survival and UV absorbance of wastewater treatment included suspended solids, turbidity, biological oxygen demand, and total organic carbon. Potential photoreactivations of 3.4 and 2.4 log, respectively, were observed for UV inactivated E. coli and S. Faecalis. Allowing for photoreactivation, the dose-required for a 99.9% inactivation of the bacteria was approximately twice that required when photoreaction was not considered. Potassium ferrioxalate actinometry provided reproduceable dose estimates, but was sensitive to procedural variations. (Cremmins-AEPCO)
W89-06940

AIR EMISSIONS OF VOLATILE ORGANICS FROM A SIMULATED HAZARDOUS LIQUID WASTE LAGOON,
Illinois Univ. at Chicago Circle. School of Public Health.
For primary bibliographic entry see Field 5B.
W89-06944

BIOLOGICAL REMOVAL OF PHOSPHORUS IN A SEQUENCING BATCH REACTOR,
Notre Dame Univ., IN. Dept. of Civil Engineering.
J. F. Manning.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8616934. Ph.D. Dissertation, 1986. 139p, 44 fig, 9 tab, 45 ref.

Descriptors: *Wastewater treatment, *Phosphorus removal, *Biological wastewater treatment, Nitrates, Nitrogen, Cations, Chemical precipitation, Nitrification.

The biological conditions necessary to achieve biological phosphorus removal in a sequencing batch reactor were determined and the effect of oxidized nitrogen and fermentation products on biological phosphorus were studied. The organic substrate fed to the bench scale reactors consisted of glucose, acetate, and casein hydrolysate which were assumed to represent the hydrolysis products of the carbohydrate, lipid, and protein fractions of wastewater. Additional nutrients were added to eliminate and trace nutrients imbalance. About 6-8 weeks were required to reduce the influent phosphorus levels of 13 g/cu m to nearly zero g/cu m. At the end of two weeks and through the third a plateau level of 5 g/cu m effluent phosphorus was achieved. During the fourth and fifth weeks, effluent biological phosphorus decreased to less than 1 g/cu m. The addition of 20 g/cu m of nitrate-nitrogen resulted in an immediate decrease in the amount of phosphorus released and eventually led to the loss of biological phosphorus removal. Other studies indicated that the presence of nitrate and nitrite reduced the release of phosphorus in the anaerobic period, but did not affect the removal of phosphorus with subsequent aeration. (Cremmins-AEPCO)
W89-06948

EVALUATION OF THE FEASIBILITY OF TWO-STAGE FILTRATION OF SETTLED WASTEWATER USING THE PULSED-BED FILTER,
California Univ., Davis.
M. J. Rengel-Aviles.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8621518. Ph.D. Dissertation, 1986. 155p, 23 fig, 88 tab, 34 ref, 7 append.

Descriptors: *Wastewater treatment, *Filtered wastewater, *Pulse-bed filters, Biological oxygen demand, Suspended solids, Flocculation, Chemical coagulation.

The feasibility was evaluated of using two-stage filtration, with or without chemical addition, to achieve an effluent meeting secondary effluent quality standards for suspended solids (SS) and BOD5 (biological oxygen demand) and to investigate pulse-bed filtration under different hydraulic loading reates and sand size. Pilot plant and jar testing and core sampling of the sand bed in the second-stage pulsed-bed filter were conducted. Findings indicate that jar tests can be used to estimate the chemical dosages for coagulation of filtered primary effluent. With improved chemical mixing and flocculation, it should be possible to achieve the same removal performance with lower chemical dosages. The efficiency of SS and BOD5 removal without chemical addition is a function of the sand size and the filtration rate. Above a sand size of about 0.55 mm, the removal efficiency for both variables is primarily dependent on filtration rate; below a sand size of about 0.25 mm, the removal efficiency for both variables is primarily dependent on sand size. Suspended solids are generally removed uniformly throughout the depth of the pulsed-bed filter. The quantity of solids removed can be estimated with an accuracy of about 20%, using influent and effluent SS measurements. (Cremmins-AEPCO)
W89-06951

DEVELOPMENT AND EXPERIMENTAL VERIFICATION OF A STRUCTURED MICROBIAL GROWTH MODEL AND AN EMPIRICAL MICROBIAL HYDROLYSIS MODEL FOR AN AEROBIC BIOLOGICAL REACTOR WITH LIGNOCELLULOSIC SUBSTRATE,
Cornell Univ., Ithaca, NY. Graduate School of Chemical Engineering.
S. S. Lee.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708906. Ph.D. Dissertation, 1987. 235p, 61 fig, 22 tab, 129 ref.

Descriptors: *Mathematical models, *Water reuse, *Recycling, *Model studies, *Wastewater treatment, *Aerobic treatment, *Biological wastewater treatment, *Ultrafiltration, Satellite technology, Microbial degradation, Ecosystems, Closed systems, Growth kinetics.

A mathematical model was developed to study the feasibility of incorporating an aerobic bioreactor and ultrafiltration unit in a closed ecological life support system (CELSS) for a space ship. A microbial growth kinetic model was developed from data obtained from an experimental system and experimentally verified for steady state and transient response. The model and technique developed are applicable for the design of terrestrial wastewater treatment systems and have potential for use in fermentation systems using ill-defined substrates with high suspended solids. The total model can be used to evaluate the feasibility of using an aerobic biological waste treatment system in a CELSS. The amount of C02 produced for a given set of reactor operating conditions can be predicted and this information can be used to determine the necessary bioreactor operating conditions to provide good control of C02 levels. The model is also useful in studying the microbial hydrolysis of lignocellulosic substrate, since carbon balance and C02 evolution rate data can be used to estimate the cell density, microbial activity, and the amount of insoluble substrate hydrolyzed. (Cremmins-AEPCO)
W89-06954

DECOMPOSITION OF WASTEWATER ORGANICS IN SOIL,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
S. R. Mistry.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8610706. Ph.D. Dissertation, 1986. 209p, 96 fig, 63 tab, 75 ref, append.

Descriptors: *Waste assimilative capacity, *Decomposing organic matter, *Wastewater treatment, *Sand, *Land reclamation, *Wastewater renovation, Loam, Chemical oxygen demand, Organic carbon, Oxygen requirements, Ammonia, Oxygen uptake.

The assimilative capacity of a Wagram loamy sand soil was determined for COD, TOC, and NH3-N removals; for the rate constants for decomposition of organics; and for the rate of oxygen utilization. Respirometers similar to the Warburg apparatus were used. Partial findings indicate that land application systems are more efficient in removing TOC and NH3N than other biological waste treatment systems. At a constant hydraulic loading rate, the leachate COD, TOC, and NH3-N concentrations increased with an increase in these concentrations in land applied waste. At constant COD, TOC, and NH-3N concentrations in land applied waste, the percent COD, TOC, and NH3-N removals decreased with an increase in hydraulic loadings. In land applied waste with high COD, TOC, and NH3-N concentrations, leachate quality of COD, TOC, and NH3-N removals should be used in the evaluation of land application system design and performance, because leaching of high concentrations of COD, TOC, and NH3-N to groundwater may lead to qualitative degradation. Treatments at hydraulic loadings of 5.0 and 7.5 cm/wk with organic loadings of 1500 and 2000 mg/L COD revealed anaerobic conditions in the soil. At land application sites containing a soil type similar to Wagram loamy sand and having a groundwater table about 1.5 to 2.0 ft from the surface, the maximum hydraulic and organic loadings should be carefully selected to protect the groundwater quality. (Cremmins-AEPCO)
W89-06966

BIOLOGICAL NUTRIENT (NITROGEN AND PHOSHORUS) REMOVAL FROM MUNICIPAL WASTEWATER USING DIFFERENT VARIATIONS OF THE ACTIVATED SLUDGE PROCESS,
Oklahoma State Univ., Stillwater. Graduate Coll.

K. Munirathinam.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8701046. Ph.D. Dissertation, 1986. 194, 81 fig, 22 tab, 128 ref.

Descriptors: *Phosphorus removal, *Wastewater treatment, *Nitrogen removal, *Denitrification, *Nitrification, *Activated sludge process, Mathematical models, Model studies, Biological oxygen demand, Chemical oxygen demand.

Continuous flow studies were conducted using one-stage nitrifying, three-stage nitrifying-denitrifying, and combined biological nitrogen and phosphorus removal systems. The first two systems were operated simultaneously. The systems were operated under different sludge retention times and food to microorganism ratios (F/M). The F/M in terms of BOD or COD appears to be the most important criterion in defining nitrification in one-stage nitrifying systems. The Kincannon and Stover model shows promise as an alternate approach for evaluating and designing one-stage nitrifying systems. Almost the same level of nitrification was achieved in both the one-stage nitrifying systems for the BOD/COD:NH3-N ratio of 110/275:30. Nitrate and nitrogen removal was very good even at the F/M value of 1.0 in the temperature range of 24 to 35 C. High percentage COD removal was observed in the anoxic (denitrification) reactor of the combined biological nitrogen and phosphorus removal system. The Kincannon and Stover model appears to be useful in evaluating combined biological nitrogen and phosphorus removal systems for the partial BOD/COD:NH3-N:P ratio with similar wastewater characteristics. (Cremmins-AEPCO)
W89-06974

5E. Ultimate Disposal Of Wastes

IN-SITU EXTRACTION OF INDUSTRIAL SLUDGES,

Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering.
I. A. Legiec, and D. S. Kosson.
Environmental Progress ENVPDI, Vol. 7, No. 4, p 270-278, November 1988. 8 fig, 2 tab, 8 ref. EPA CA807805.

Descriptors: *Waste Treatment, *Wastewater treatment, *Water pollution treatment, *Organic compounds, *Decontamination, Wastes, *Industrial wastes, *Sludge, Sludge disposal, Pilot plants, Carbon, Organic carbon, Acidity, Nutrients, Degradation, Biodegradation, Sodium hydroxide.

A pilot plant was constructed at an industrial sludge lagoon where a forced extraction system for cleaning up groundwater pollution was operated in situ for two years. Extract total organic carbon (TOC) levels from the extraction bed decreased from 11,000 to 4,000 mg/L in 1985, and from 6,500 to 2,200 mg/L in 1986. Laboratory studies performed on split-spoon core samples obtained from the extraction bed revealed information on the uniformity of the extraction process, and efficiency in contaminant removal. The extent of the forced extraction process was investigated in a two-step extraction procedure. Primary sludges exhibited a pH dependency, with maximum extractable TOC obtained at an equilibrium pH of 10.5 to 11. Core samples obtained at 4-6 and 12-14 ft are representative of effectively treated primary and secondary sludges. Comparison of their equilibrium TOC from extractions using pH 12.5 NaOH to the TOC (liquid) versus TOC (solid) curves reemphasizes the effectiveness of the forced extraction system. (Author's abstract)
W89-05811

RISK ANALYSIS OF AQUIFER CONTAMINATION BY BRINE,

Case Western Reserve Univ., Cleveland, OH. Dept. of Systems Engineering.
For primary bibliographic entry see Field 2F.
W89-05820

SHRINKAGE BEHAVIOR OF CLAY LINER MATERIAL EXPOSED TO SIMULATED MUNICIPAL SOLID WASTE LANDFILL LEACHATE,

Alberta Univ., Edmonton. Dept. of Civil Engineering.
J. P. A. Hettiaratchi, S. E. Hrudey, D. W. Smith, and D. C. C. Sego.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 500-508, August 1988. 6 fig, 7 tab, 24 ref.

Descriptors: *Solid wastes, *Clays, *Linings, *Hydraulic conductivity, *Leachates, *Liners, *Water pollution prevention, *Municipal wastes, Sanitary landfills, Solid waste disposal, Sedimentation rates, Stress.

The use of hydraulic conductivity (k) of soil material as the sole basis for sanitary landfill liner design is reviewed. On one hand, k measurements obtained in the laboratory often vary by several orders of magnitude. On the other, laboratory-measured k values fail to address field behavior, where crack formation before and (or) during landfill operation may control the bulk permeability. A synaerisis shrinkage test (SST) to study the soil shrinkage caused by municipal solid waste (MSW) leachates is introduced. Leachates cause soil shrinkage by reducing interparticle repulsive stresses thereby increasing effective stress. The effective stress concept and double layer theory adequately describe the synaerisis shrinkage phenomenon. A strong correlation was obtained between percent strain, the soil-liquid parameter determined from SST results, and a volume change parameter (free swell difference, FSD) from sedimentation test results. The results provide a basis for a broader approach to landfill liner design. The SST, which supplies information on both volume shrinkage and permeability changes caused by leachate, provides a useful laboratory procedure for evaluating liner materials. (Author's abstract)
W89-05822

ROLE OF SATURATED AND UNSATURATED ZONE IN SOIL DISPOSAL OF SEPTIC TANK EFFLUENT,

Government of the Northwest Territories, Yellowknife. Municipal and Community Affairs.
K. R. Johnson, and J. W. Atwater.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 709-716, August 1988. 6 fig, 7 tab, 19 ref.

Descriptors: *Aeration zone, *Soil disposal fields, *Effluents, *Septic tanks, *Wastewater disposal, *Saturation zone, Canada, Coliforms, Chemical oxygen demand, Ammonia, Nitrates, Phosphates, Path of pollutants, Nitrification, Nutrients, Domestic wastes, Septic wastewater.

The guidelines for the use of the septic tank - soil absorption system (ST-SAS) in the Province of British Columbia are very specific in regard to the separation distance between the ground surface and the groundwater table (minimum 1.2 m), and between the tile field and perimeter drains or ditches (minimum 3.0 m). A pilot-scale experiment employing waterproof channels filled with a saturated soil was used to evaluate the scientific basis for these guidelines. Septic tank effluent was applied to unsaturated columns and the inlet end of the channels and samples were taken at different points in the channels. Measurements were made of total and fecal coliforms, chemical oxygen demand, ammonia, nitrate, and orthophosphate. Coliform reductions within the channels were at least 30,000-fold with total coliform number generally lying below 200 coliforms/100 ml and fecal coliforms generally less than 50 coliforms/100 ml. Varying degrees of nitrification occurred in the unsaturated columns, resulting in relatively high concentrations of nitrate in some of the channel sections (1-7 mg/L in channels filled with sand and 0.1-1.0 mg/L in channels filled with loamy sand). The removal of orthophosphate was greater than 90% in all of the channel sections, independent of the saturated or unsaturated zones. Reductions in measured influent parameters were substantial in all of the channels. This suggest that the guidelines may be conservative with respect to these particular soils. Of concern are the high nitrate values observed in some of the channels, therefore consideration of nitrification potential should be made in conjunction with the potential for reduction of other contaminants. (Author's abstract)
W89-05829

AUSTIN BENEFITS FROM SLUDGE COMPOSTING PROGRAM,

Austin Water and Wastewater Utility, TX.
J. Doersam.
Biocycle BCYCDK, Vol. 29, No. 10, p 40-41, November-December 1988. 1 tab, 3 ref.

Descriptors: *Texas, *Composting, *Wastewater facilities, *Sludge disposal, *Land application, Anaerobic digestion, Wastewater treatment, Sludge marketing, Beltsville windrow process, Dillo Dirt, Heavy metals, Cadmium, Copper, Zinc, Lead, Nickel, Polychlorinated biphenyls, Public health, Seasonal distribution, Austin.

The Hornsby Bend Wastewater Treatment Facility of the City of Austin, Texas, has recently been improved by the construction of 8 new anaerobic digesters, five 5-acre sludge drying basins, a greenhouse-enclosed water hyacinth facility, and a 160-acre on-site irrigation system. In the past, the City lagooned all waste sludge, but this created a major sludge inventory problem. A composting program was developed that operates on the principle of the EPA-developed Beltsville windrow process. The process of composting sludge at this facility is described, and the marketing of the product as 'Dillo Dirt' is discussed. The sludge product levels of Cd, Cu, Ni, Pb, Zn, and polychlorinated biphenyls are all well below Texas Department of Health limits for composted sludge distributed in 'uncontrolled use.' When combined with agricultural land application, composting of sludge gives the beneficial reuse program flexibility to prevent an inventory problem during all seasons of the year. (Rochester-PTT)
W89-05834

ALTERNATIVE BULKING AGENT FOR SLUDGE COMPOSTING,

Los Angeles County Sanitation Districts, Carson, CA.
For primary bibliographic entry see Field 5D.
W89-05835

NUMERICAL MIXING ZONE MODEL FOR WATER QUALITY ASSESSMENT IN NATURAL STREAMS: CONCEPTUAL DEVELOPMENT,

Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-05884

RELATIVE CONCENTRATIONS OF CADMIUM AND ZINC IN TISSUE OF SELECTED FOOD PLANTS GROWN ON SLUDGE-TREATED SOILS,

Won Kwang Univ., Iri (Republic of Korea). Dept. of Agricultural Chemistry.
S. J. Kim, A. C. Chang, A. L. Page, and J. E. Warneke.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 568-573, October-December 1988. 9 tab, 23 ref.

Descriptors: *Sludge utilization, *Soils, *Cadmium, *Zinc, *Plant physiology, *Path of pollutants, Vegetable crops.

Twelve selected food plants were grown in greenhouse pots to determine the relative concentrations of Cd and Zn in the plants grown in sludge-treated soils. The relative concentration of the metal was calculated as the quotient of the metal content in a plant and that in Swiss chard (Beta vulgaris subsp. cicla) grown under the same soil conditions. The relative concentrations of Cd and Zn of food plants grown in several sludge-treated soils were significantly different ($p < 0.01$) but the relative concentrations of these plants in one soil has the statistical

characteristics (e.g. range, mean, median, coefficient of variation, etc.) as those in another soil. (Author's abstract)
W89-05928

TRICKLE IRRIGATION OF COTTON WITH TREATED SEWAGE EFFLUENT,
Agricultural Research Inst., Nicosia (Cyprus).
I. Papadopoulos, and Y. Stylianou.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 574-580, October-December 1988. 12 tab, 33 ref.

Descriptors: *Municipal wastewater, *Wastewater irrigation, *Trickle irrigation, *Cotton, *Nitrogen, *Nitrates, *Fertilization, Sodium, Soil, Salinity.

This field study, conducted in 1984 through 1986, investigated the long-term effects of applying treated municipal effluent by trickle irrigation on soil N fertility, soil salinity, and yield of cotton (Gossypium hirsutum) under semiarid conditions. Secondary treated effluent was compared with borehole water. Both waters were supplemented with 0, 30, 60, and 90 mg N/L. The N concentration in the effluent was about 30 mg/L during the 3 years of experimentation. The residual soil NO3-N and the NO3-N concentrations in laminae and petioles were in general greater in the effluent-irrigated crops. With both waters, excessive salt buildup occurred at the periphery of the wetting front. Sodium adsorption ratio was reduced beneath the dripper in the surface 15 and 30 cm depth with borehole water and effluent, respectively, but below this depth the reverse occurred. Under the conditions of soil type, climate, and borehole water and effluent qualities used during this experiment, effluent was generally superior to borehole water, particularly at the lower N levels in increasing yields. The seedcotton yield obtained in the first season was significantly greater in the effluent irrigated treatments supplemented with N up to 60 mg/l; in 1985 and 1986, yield with treated effluent was significantly higher in comparison with borehole water when additional N of 30 mg/L was applied. Municipal-treated effluent containing 30 mg N/L can apparently be used effectively by trickle irrigation systems as a source of irrigation water and N, and with appropriate N and water management, ecological hazards due to NO3-N are minimized, and salinity and sodicity are maintained at acceptable levels for cotton. (Author's abstract)
W89-05929

MUNICIPAL SLUDGE FOR MINESPOIL RECLAMATION: I. EFFECTS ON MICROBIAL POPULATIONS AND ACTIVITY,
Philadelphia Water Dept., PA.
E. M. Seaker, and W. E. Sopper.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 591-597, October-December 1988. 1 fig, 8 tab, 47 ref. EPA Grant R811248-01.

Descriptors: *Mine wastes, *Spoil banks, *Coal mining, *Strip mines, *Soil management, *Mine spoil, *Land reclamation, *Sludge utilization, Municipal wastewater, Soil bacteria, Soil fungi, Actinomycetes, Fertilization, Respiration, Organic matter, Heavy metals, Trace metals, Grasses, Legumes, Decomposition.

A field study of 5 coal surface mine sites reclaimed with sewage sludge and one site reclaimed by conventional methods (chemical fertilizer) was conducted to assess the effects of sludge amendments and time on populations of bacteria, fungi, and actinomycetes, and on microbial respiration and organic matter decomposition. The sludge-amended sites ranged in age from 1 to 5 yr following sludge application at rates of 120 to 134 Mg/ha (dry wt. basis). All sites were planted to grass and legume cover. Populations of aerobic heterotrophic bacteria, fungi, and Nitrobacter, and soil respiration rate, were highest on the 1-yr-old site due to the high organic matter input. On the four older sites, values decreased, but remained within the ranges reported for undisturbed soils. Actinomycete populations peaked on the 3-yr-old and 4-yr-old sites, while populations of Nitrosomonas were not related to the age of the site. Decomposition rate was lowest on the 1-yr-old site, and increased significantly with site age. As measured by microbial populations and activity, ecosystem recovery on the sludge-amended sites appeared to be occurring at a more rapid rate than on the fertilizer-amended site, which after 5 yr, exhibited sparse microbial populations and low activity. The microbial populations in the sludge-amended spoil were not adversely affected by the heavy metals applied in the sludge, when compared with populations of soil microbes reported for undisturbed soils. (See also W89-05931) (Author's abstract)
W89-05930

MUNICIPAL SLUDGE FOR MINESPOIL RECLAMATION: II. EFFECTS ON ORGANIC MATTER,
Philadelphia Water Dept., PA.
E. M. Seaker, and W. E. Sopper.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 598-602, October-December 1988. 3 tab, 28 ref. EPA Grant R811248-01.

Descriptors: *Fertilization, *Soil banks, *Mine wastes, *Coal mining, *Strip mines, *Mine spoil, *Land reclamation, *Sludge utilization, Municipal wastewater, Soil management, Organic matter, Organic carbon, Nitrogen compounds, Grasses, Legumes, Root development, Detritus, Dry matter.

A field study of 5 coal stripmines reclaimed with sewage sludge and one site reclaimed with chemical fertilizer was conducted to determine the effects of sludge amendments and time on dry matter yields, detritus accumulation, root growth, organic matter content, and soil organic C and N content. The reclaimed sites ranged in age from 1 to 5 yr following reclamation with sludge at rates of 120 to 134 Mg/ha (dry wt. basis). The fertilizer-amended site was 5 yr old. All sites were planted in grass and legume cover. On the sludge-amended sites, yield, detritus, root growth, and organic matter were positively correlated with site age, increasing from the 1-yr-old to the 3-yr-old site. On the 4-yr-old and 5-yr-old sites values were greater than or equal to the 2-yr-old site, and no indication of site deterioration was evident. Organic C significantly increased from the 1-yr-old to the 2-yr-old site, and was highest on the 5-yr-old site. Total N remained constant on all sites. On the 3 older sites detritus accumulation and root growth surpassed that of the 5-yr-old fertilizer-amended site. Yield and organic matter content on the 4 oldest sludge sites surpassed that of the fertilizer-amended site, and organic C and N content on all sludge sites surpassed that of the fertilizer-amended site. As measured by these parameters, eventual soil development and ecosystem recovery appear to be accelerated on the sites reclaimed with sludge compared to the fertilizer-amended site. (See also W89-05930) (Author's abstract)
W89-05931

SUBSOIL THICKNESS EFFECTS ON YIELD AND SOIL WATER RECLAIMING SODIC MINESPOIL,
Monenco Consultants Ltd., Calgary (Alberta).
T. A. Oddie, and A. W. Bailey.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 623-627, October-December 1988. 1 fig, 5 tab, 26 ref.

Descriptors: *Coal mining, *Mine spoil, *Soil banks, *Subsoil, *Land reclamation, *Soil water, *Crop yield, Barley, Cereal crops, Alfalfa, Bromegrass, Forages, Soil, Canada.

Minespoil sodicity has the potential to limit plant growth and impede reclamation success on surface-mined land. A joint government/coal industry experiment was established near Highvale, Alberta, to determine suitable subsoil thickness (0, 55, 95, 135, and 345 cm underlying 15 cm topsoil) for reclaiming sodic minespoil and maximizing production of an annual barley (Hordeum vulgare) cereal crop or a perennial alfalfa-smooth bromegrass (Medigo sativa, Bromus inermis) forage mixture. Barley and forage yields were lower on the 0-cm subsoil treatment than on all other treatments. Yields for both crops increased as subsoil thickness increased to 55 cm. There was a consistent trend toward optimum yields on the 95-cm subsoil treatment, but the difference between 55 and 95 cm was not significant. The replacement of 55 to 95 cm subsoil plus 15 cm topsoil appeared sufficient to restore post-mine productivity to the potential achieved on surrounding agricultural land. Root depth under the forage mixture increased as total soil thickness increased, while increases under the cereal were not generally significant. The average effective root zone extended to about 85 cm under barley and 185 cm under alfalfa-smooth bromegrass. Average seasonal soil water within the effective subsoil root zone generally increased under barley and decreased under alfalfa-smooth bromegrass over time. Lower consumptive use of available soil water and a shallower effective root zone under barley contributed to accumulations of soil water above the subsoil/minespoil interface. Perennial forages appeared to be more effective in reducing soil water accumulations above the interface and promoting reclamation success of sodic minespoil. (Author's abstract)
W89-05935

GROUNDWATER AND SOIL LEACHATE INORGANIC NITROGEN IN A WISCONSIN RED PINE PLANTATION AMENDED WITH PAPER INDUSTRY SLUDGE,
Wisconsin Univ., Madison. Dept. of Soil Science.
J. G. Bockheim, T. C. Benzel, R.-L. Lu, and D. A. Thiel.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 729-734, October-December 1988. 5 fig, 20 ref.

Descriptors: *Pulp and paper industry, *Sludge disposal, *Sludge utilization, *Pine trees, *Soil, *Leachates, *Groundwater, *Nitrogen, *Nitrates, *Ammonium, Seasonal variation, Wisconsin.

In late August 1984, a 2.5:1 primary/secondary paper industry sludge was applied to a row-thinned, 27-yr-old red pine (Pinus resinosa) plantation in central Wisconsin at levels of 32, 63, and 94 dry Mg/ha (550, 1120, and 1670 kg N/ha, respectively). There were positive treatment effects on nitrate-N and ammonium-N in soil leachates and groundwater, but because of sample variability, few of these differences were significant at the $p < or = 0.05$ level. Nitrate-N concentrations exceeded 10 mg/L for all treatments at the 10-, 45-, and 75-cm depths, but the potability standard was exceeded at the 165-cm depth and in groundwater only on plots receiving the medium and heavy applications. Nitrate-N concentrations generally were greater in the upper 30 cm of the saturated zone than at 60 and 90 cm, suggesting a lack of vertical mixing. Whereas the maximum nitrate-N concentration decreased with depth, the time required for nitrate-N to exceed 10 mg/L for a given treatment and the duration of the period when nitrate-N exceeded 10 mg/L increased with depth. The seasonal trends in inorganic N in soil water collected at the 10-cm and 45-cm depths could be explained on the basis of N mineralization as derived from field incubation studies. A regression equation relating maximum nitrate-N in groundwater to N content of the applied sludge indicates that little groundwater degradation will occur at depths of $> or = 5.2$ m when the N application to pole-sized red pine is $< or = 800$ kg/ha ($< or = 46$ dry Mg sludge/ha). (Author's abstract)
W89-05941

BIODEGRADATION OF OZONATED ATRAZINE AS A WASTEWATER DISPOSAL SYSTEM,
Agricultural Research Service, Beltsville, MD. Pesticide Degradation Lab.
P. C. Kearney, M. T. Muldoon, C. J. Somich, J. M. Ruth, and D. J. Voaden.
Journal of Agricultural and Food Chemistry JAFCAU, Vol. 36, No. 6, p 1301-1306, November/December 1988. 6 fig, 1 tab, 23 ref.

Descriptors: *Herbicides, *Biodegradation, *Ozonation, *Wastewater disposal, Atrazine, Soil metabolism, Wastewater treatment, Hydrogen ion concentration.

Destruction of atrazine (2-chloro-4-(ethylamino)-6-(isopropylamino)-s-triazine) by ozonation and subsequent soil biodegradation was examined as a low-volume two-step dilute wastewater disposal system. Ozonation of atrazine resulted in a number of products in which alkyl groups were altered and eventually removed, the halogen was slowly removed, and the s-triazine remained essentially intact. The rate of chemical interconversions of these products was accelerated at higher pH values. The rate of subsequent soil metabolism of these products is enhanced by prior oxidative dealkylation, deamination and dehalogenation reactions. These reactions can be scaled up to provide a fairly efficient and inexpensive disposal option for on-site wastewater treatment. (Miller-PTT)
W89-05947

SITE DESIGN FOR RESOURCE RECOVERY FACILITIES,
Burns and Roe, Inc., Oradell, NJ.
J. Nir, M. Patel, and B. Cividini.
Journal of Energy Engineering JFEED9, Vol. 114, No. 3, p 93-98, December 1988. 2 fig, 1 tab.

Descriptors: *Resources management, *Design criteria, *Site selection, *Waste disposal, *Waste recovery, *Planning, Project planning, Incineration, Public opinion, Water pollution prevention, Storm runoff, Capital costs, Maintenance costs, Refuse-derived fuel.

Specific site design for waste-to-energy resource recovery facilities, both mass-burn and refuse-derived fuel, are considered. Site design considerations presented here are applicable to both categories, but layout and system description used is for mass-burn facilities. The project site is identified through a complex screening process that includes issues such as environmental compatibility and public sentiment. Site layout and aesthetics of the facility are of utmost importance to win public support. Traffic congestion is an issue which may be of particular concern to residents in the area of the project. Therefore, it is essential that sufficient on-site truck queuing space be provided to avoid traffic spillover onto public streets. A storm-water drainage system must be designed to prevent water pollution during the construction, and in many instances, to maintain predevelopment runoff rate from the site. Finally the economic consideration dictates that the site must be designed to minimize both capital and maintenance costs. (Author's abstract)
W89-05953

STUDIES ON THE MECHANISM OF PHOSPHORUS REMOVAL FROM TREATED WASTEWATER BY SAND,
Rensselaer Polytechnic Inst., Troy, NY. Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-05972

EFFECTS OF SEWAGE SLUDGE DISPOSAL TO SEA - THE OUTER THAMES ESTUARY, U.K.,
Water Research Centre, Medmenham (England).
For primary bibliographic entry see Field 5C.
W89-06033

MINERALIZATION OF PHOSPHORUS IN SLUDGE-AMENDED SOILS MONITORED BY PHOSPHORUS-31-NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY,
Florida Univ., Gainesville. Dept. of Soil Science.
Z. R. Hinedi, A. C. Chang, and R. W. K. Lee.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1593-1596, November-December 1988. 5 fig, 1 tab, 27 ref. NSF Grant DMB8604091, DOE Grant FT03-86FR13535, NIH PHS Grant BRSG2507 and NSF Grant CHE-82-03497.

Descriptors: *Phosphorus, *Sludge disposal, *Sand disposal, *Soil amendments, Soil types, Acidic soils, Alkaline soils, Nuclear magnetic resonance, Spectroscopy, Microbial degradation.

The changes occurring in the different phosphorus pools in sludge-amended soils during incubation were observed using 31P nuclear magnetic resonance spectroscopy (31P NMR) to qualitatively and quantitatively register phosphorus transformations. An acid and an alkaline soil were each incubated with sludges that underwent different digestion processes. The 31P NMR spectra of those soils after 1, 28, 70, and 140 days of incubation showed that phosphorus diesters completely hydrolyzed after 28 days of incubation in both soils, irrespective of the type of sludge incorporated. After 140 days of incubation, phosphorus monoesters were still detected in the acid soil while they had completely hydrolyzed in the alkaline soil. Pyrophosphates were detected after 70 days of incubation in the alkaline soil and 140 days of incubation in the acid soil. The study suggested that acidity has an adverse effect on the microbial degradation of phosphorus monoesters and pyrophosphates in sludge-amended soils. (Author's abstract)
W89-06079

HUMAN EXPOSURE TO POLYCHLORINATED BIPHENYLS AT TOXIC WASTE SITES: INVESTIGATIONS IN THE UNITED STATES,
Center for Disease Control, Atlanta, GA.
For primary bibliographic entry see Field 5C.
W89-06175

DETERMINATION OF URANIUM IN NATURAL GROUNDWATERS USING HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY,
Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment.
For primary bibliographic entry see Field 5A.
W89-06176

LONG TERM EFFECTS OF VARYING LEVELS OF BOD OF IRRIGATION WATERS ON CROPS,
National Environmental Engineering Research Inst., Nagpur (India).
For primary bibliographic entry see Field 3C.
W89-06180

OCEAN OUTFALLS. I: SUBMERGED WASTEFIELD FORMATION,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
P. J. W. Roberts, W. H. Snyder, and D. J. Baumgartner.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 1-25, January 1989. 2 tab, 12 fig, 18 ref, append.

Descriptors: Outfalls, *Wastewater dilution, *Wastewater disposal, *Wastewater outfall, *Ocean dumping, *Structural models, Wastefields, Diffusers, Plumes, Water currents, Line plume.

Experiments to study the dilution and formation of wastefields resulting from discharge into a linearly density-stratified steady current of arbitrary speed and direction were conducted using a model multiport diffuser for a range of parameters typical of ocean wastewater outfalls. Results are given from which the established wastefield characteristics for the 'line plume' source conditions can be predicted. In general, the wastefield rise height and thickness decrease as the current speed increases. Dilution increases with current speed for all current directions, with diffusers perpendicular to the current resulting in higher dilutions than when parallel. Concentration profiles for perpendicular currents show little horizontal structure as the individual plumes rapidly merge. The results for dilution show no dependence on port spacing or source momentum flux over the parameter range tested, and the dominant source parameter is the buoyancy flux per unit length. The results confirm the value of the 'line plume' approximation for predicting dilutions for deep-water ocean outfalls over a fairly wide parameter range. (See W89-06276 thru W89-06277) (Author's abstract)
W89-06275

OCEAN OUTFALLS. II: SPATIAL EVOLUTION OF SUBMERGED WASTEFIELD,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
P. J. W. Roberts, W. H. Snyder, and D. J. Baumgartner.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 26-48, January 1989. 1 tab, 10 fig, 22 ref.

Descriptors: Outfalls, *Wastewater dilution, *Wastewater disposal, *Wastewater outfall, *Ocean dumping, Wastefields, Diffusers, Plumes, Mixing, Water currents.

Basic features of submerged wastefield formation in stratified currents are reported. Dilution increased with distance from the diffuser in the initial mixing region until it attained a maximum value, which is the initial dilution, after which it remained constant. By assuming a model of buoyancy-induced turbulence collapse, expressions for the observed dependency on current speed in the forced entrainment regime of initial dilution, rise height, and mixing region length were obtained. An expression for lateral spreading in parallel currents was derived which was found to be of the same form as for unstratified currents, except that the rate of spreading in perpendicular currents was derived by applying results from mixed-region collapse. An applications example shows that the initial mixing region can extend for several hundred meters downstream from the discharge. Because of gravitational spreading, a line diffuser will produce a wastefield width comparable to the diffuser length for most oceanic conditions, suggesting that Y or similarly complex diffuser configurations are not necessary to produce a widely dispersed wastefield. (See also W89-06275 and W89-06277) (Author's abstract)
W89-06276

OCEAN OUTFALLS. III: EFFECT OF DIFFUSER DESIGN ON SUBMERGED WASTEFIELD,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
P. J. W. Roberts, W. H. Snyder, and D. J. Baumgartner.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 49-70, January 1989. 5 tab, 8 fig, 10 ref, 2 append.

Descriptors: Outfalls, *Wastewater dilution, *Wastewater disposal, *Wastewater outfall, *Ocean dumping, Design criteria, Plumes, Wastefields, Diffusers, Mixing, Water currents.

The effects of port spacing and jet momentum flux on the characteristics of submerged wastefields produced by multi-port ocean outfalls in linearly stratified currents were investigated experimentally. Within the parameter range studied the primary effect of these variables is on the rise height and thickness of the wastefield, and dilution is closely approximated by line plume results. Increased momentum flux causes a reduction in rise height at low current speeds while leaving the total entrainment path length of the jets, and hence dilution, fairly constant. The effects of increased momentum flux decrease as the current speed increases. Increased port spacing still resulted in merging of individual plumes even when fairly widely spaced, particularly in flowing currents, so point plume results were of limited applicability in predicting wastefield properties. For municipal sewage discharges into coastal waters, the dominant source parameter becomes the discharge per unit length. Since the total discharge is presumably specified, the diffuser length is the primary design variable with the diffuser details exerting little influence on effluent dilution for a fairly wide range of typical outfall conditions. (See W89-06275 thru W89-06276) (White-Reimer-PTT)
W89-06277

MASS BALANCE DURING SUBSOIL IRRIGATION OF DOMESTIC SEWAGE: EXPERIMENTAL SET-UP AND PRESENT RESULTS (STOFFBILANZ IM SYSTEM BODEN-BODEN-LUFT-WASSER BEI DER ABWASSERVERSICKERUNG: VERSUCHSAUFBAU UND ERSTE ERGEBNISSE),

Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl und Pruefamt fuer Wasserguetewirtschaft und Gesundheitsingenieurwesen.
For primary bibliographic entry see Field 5D.
W89-06283

MEASUREMENTS OF THE DISPERSION OF LIQUID INDUSTRIAL WASTE DISCHARGED INTO THE WAKE OF A DUMPING VESSEL,
Ministry of Agriculture, Fisheries and Food, Burnham on Crouch (England). Fisheries Lab.
C. D. Byrne, R. J. Law, P. M. Hudson, J. E. Thain, and T. W. Fileman.
Water Research WATRAG, Vol. 22, No. 12, p 1577-1584, December 1988. 5 fig, 3 tab, 16 ref.

Descriptors: *Dispersion, *Wastewater disposal, *Ocean dumping, *Industrial wastewater, *Path of pollutants, *Waste management, On-site tests, Chemical wastes, Effluents.

100,000 t/yr of acidic effluent with an organic content of 3-7% are dumped 15 km off the mouth of the River Tees in water 50 m deep. In order to achieve adequate dilution, the rate of discharge of this effluent has been restricted on the basis of calculations made using a formula adopted by the International Maritime Organization (IMO, formerly IMCO). To ensure that these calculated minimum conditions were achieved in practice, field measurements of waste concentration in the wake of the dumping vessel were made on 3 days under different climatic conditions. The measurements were made by a number of methods, both in situ and involving analysis in a laboratory onshore. The dilutions calculated from the 'IMCO formula' were compared with those found in practice and the formula was found to underestimate dilution in this case. The results obtained are compared with other theoretical and practical studies. (Author's abstract)
W89-06306

SELECTION OF HAZARDOUS WASTE DISPOSAL ALTERNATIVE USING MULTI-ATTRIBUTE UTILITY THEORY AND FUZZY SET ANALYSIS,
Pennsylvania Univ., Philadelphia. Dept. of Systems Engineering.
G. Anandalingam, and M. Westfall.
Journal of Environmental Systems JEVSB, Vol. 18, No. 1, p 69-85, 1988. 9 tab, 20 ref.

Descriptors: *Industrial wastes, *Mathematical analysis, *Waste disposal, *Decision making, Multi-attribute utility theory, Fuzzy set analysis, Polychlorinated biphenyls, Transformer fluids, Hazardous materials.

The problem of choosing a hazardous waste disposal alternative is examined, where there are multiple attributes associated with each site, and the decision maker has imprecise information regarding the impact of the waste on each site, and the decision maker's preference ordering for each attribute. It is shown how developments in multi-attribute utility theory (MAUT) and fuzzy set analysis can be used to address the problem. These methodologies were applied to a case study concerning the disposal of PCB contaminated transformer fluids at one of three incineration sites. The sites were evaluated based on ten criteria including surface water quality, groundwater quality, ecology, and land use. MAUT is superior to fuzzy set analysis in cases where there is imprecision in either value scores or preference weights, but not both. (Author's abstract)
W89-06403

ENVIRONMENTAL IMPACTS AND REGULATORY POLICY IMPLICATIONS OF SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
D. R. Cahoon, and J. H. Cowan.
Coastal Management CZMJBF, Vol. 16, No. 4, p 341-362, 1988. 3 tab, 6 fig, 21 ref. Louisiana Sea Grant College Program, Project Number R/MPE-37-PD.

Descriptors: *Waste disposal, *Environmental policy, *Regulations, *Louisiana, *Dredging, *Spoil banks, *Spoil disposal, *Wetlands, Environmental effects, Spray disposal, High-pressure spray spoil disposal, Policy making, Decision making, Legal aspects, State jurisdiction, Federal jurisdiction.

The capabilities of a new wetland dredging technology were assessed along with associated newly developed state and federal regulatory policies to determine if policy expectations realistically match the technological achievement. Current regulatory practices require amelioration of spoil bank impacts upon abandonment of an oil/gas well, but this may not occur for many years or decades, if at all. Recently, a dredging method (high-pressure spray spoil disposal) was developed that does not create a spoil bank in the traditional sense. Its potential for reducing environmental impacts was recognized immediately by regulatory agencies for whom minimizing spoil bank impacts is a major concern. The use of high-pressure spray disposal as a suitable alternative to traditional dredging technology has been adopted as policy even though its value as a management tool has never been tested or verified. A qualitative evaluation at two spoil disposal sites in saline marsh indicates that high-pressure spray disposal may indeed have great potential to minimize impacts, but most of this potential remains unverified. Also, some aspects of current regulatory policy may be based on unrealistic expectations as to the ability of this new technology to minimize or eliminate spoil bank impacts. (Author's abstract)
W89-06404

HEAVY METAL VARIABILITY OF DIFFERENT MUNICIPAL SLUDGES AS MEASURED BY ATOMIC ABSORPTION AND INDUCTIVELY COUPLED PLASMA EMISSION SPECTROSCOPY,
Washington Univ., Seattle. Dept. of Environmental Health.
A. E. Nevissi, F. B. DeWalle, J. F. C. Sung, K. Mayer, and R. Dalsey.
Journal of Environmental Science and Health JESEDU, Vol. A23, No. 8, p 823-841, 1988. 8 tab, 6 ref.

Descriptors: *Municipal waste, *Sludge disposal, *Heavy metals, Spectroscopy, Atomic absorption spectroscopy, Emission spectroscopy, Nutrients, Variability, Inductively Coupled Plasma Emission Spectroscopy, Alum sludge, Arsenic.

Six sludge streams were intensively monitored for their metal content, using an ampul digestion technique with AA and ICP quantification. Most of the variability in metal content was related to the type of sludge sampled (primary sludge, waste-activated sludge, digested sludge, dewatered sludge), and to a lesser extent to the day-to-day changes of a particular sludge stream. A small variability was contributed by the within-laboratory analysis variability. The reliability of the analysis was confirmed by mass balances at consecutive points during the sludge processing. Addition of alum to the sewage to increase primary removal efficiency greatly increased the arsenic content of the sludge. (White-Reimer-PTT)
W89-06412

INFILTRATION THROUGH LAYERED-SOIL TRENCH COVERS: RESPONSE TO AN EXTENDED PERIOD OF RAINFALL,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5G.
W89-06428

FLUID BED TECHNOLOGY FOR SLUDGE DESTRUCTION,
CWC-HDR, Inc., Edmonds, WA.
B. Hemphill.
Water Engineering and Management WENMD2, Vol. 135, No. 12, p 37-40, December 1988.

Descriptors: *Fluidized beds, *Incineration, *Sludge disposal, *Wastewater treatment, Municipal wastewater, Technology, Fuel, Process control, Temperature, Oxygen, Monitoring, Pumps, SEnsors, Sludge conditioning.

The use of fluidized bed furnaces (FBF) for the incineration of municipal sewage sludge is reviewed. Sludge is combusted within a bed of fluidized silica sand maintained in a fluidized state by an upward flow of combustion air. This bed provides a highly turbulent zone in which sludge particles are disintegrated and violently mixed with air and fuel. There are two basic types of FBF systems design: the cold windbox style, and the hot windbox, designed to withstand high temperatures and lined with refractory and insulating material. Auxiliary fuel may be injected directly into the fluidized bed when needed to maintain combustion. Operation at positive pressure requires special design of the sludge feed system. Three types of feed mechanisms have been used: injection screw feeders, progressive cavity pumps, and piston-type positive displacement pumps. Most new installations include a high-pressure drop venturi scrubber, followed by an impingement tray scrubber/cooler compartment. Ash is carried out with the exhaust gases. Sensors measure critical variables such as temperature, pressure, and exhaust gas oxygen. Recent advances make the goal of autogenous operation (without supplemental fuel) attainable without the use of exotic conditioning systems. (Doria-PTT)
W89-06548

GOING WITH THE FLOW: USDA'S DUBIOUS COMMITMENT TO WATER QUALITY,
For primary bibliographic entry see Field 5G.
W89-06590

ENVIRONMENTAL INFORMATION DOCUMENT: WASTE OIL BASINS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
L. A. Huber, W. F. Johnson, and H. W. Bledsoe.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-000760. Price codes: A06 in paper copy, A01 in microfiche. Report No. DPST--85-701, March 1987. 116p, 25 fig, 31 tab, 34 ref, append. DOE Contract DE-AC09-76SR00001.

Descriptors: *Land disposal, *Environmental effects, *Water pollution sources, *Oil wastes, *Path of pollutants, Oil, Kerosene, Ethylene glycol, Surfactants, Hydrogen sulfide, Organic compounds, Groundwater pollution, Halogens, Tetrachloroethylene, Public health, Fate of pollutants, Model studies, Cleanup operations, Observation wells, Cores.

Oil basins, located in A-Area and D-Area at the Savannah River Plant (SRP), were constructed and placed in service to receive liquid waste from the 716-A Motor Shop oil/water separator. Effluent discharges from the Motor Shop and waste oil products from D-Area included wastewater with trace amounts of engine oil, grease, kerosene, ethylene glycol, soapy water, and waste oils that may have contained hydrogen sulfide, chlorinated organics, and other chemicals. Both basins are inactive today, and are covered with natural vegetation, including bushes and grasses. The liquid waste in the Motor Shop oil basin has been characterized but no soil cores have been collected and analyzed. Two groundwater monitoring wells have been installed at the basin and sampled quarterly beginning in 1984. Results from groundwater quality analyses indicate elevated levels of total organic halogens, which are attributed to chlorinated hydrocarbon contamination sources from nearby M area. No soil cores from the D-Area oil basin have been collected or analyzed. Four groundwater monitoring wells have been installed at the basin and sampled quarterly starting in 1984. Slightly elevated levels of total organic halogens were detected in one of the wells. An elevation of environmental impacts from the D-Area oil basin indicates that the relative risks to human health and ecosystems for the postulated closure options are low. The transport of one chemical constituent (tetrachloroethylene) through the environmental pathways from the D-Area oil basin was modeled.

The maximum carcinogenic risk in all three groundwater pathways is from exposure to tetrachloroethylene for all closure options and occurs at Year 100 immediately following the period of institutional control. There are no other risks associated with any of the other exposure pathways. The cost estimates show the waste removal and closure option to be the most expensive: $230,000 for the Motor Shop oil basin and $590,000 for the D-Area oil basin. The other closure options are less expensive up to a factor of 3 for the no action option. (Lantz-PTT)
W89-06647

BENEFICIAL USES OF DREDGED MATERIAL IN SHALLOW COASTAL WATERS; CHESAPEAKE BAY DEMONSTRATIONS,
Corps of Engineers, Baltimore, MD. Baltimore District.
G. Earhart, D. Clarke, and J. Shipley.
Waterways Experiment Station Information Exchange Bulletin Vol D-88-6, December 1988. 7p, 2 fig, 2 tab, 1 ref.

Descriptors: *Waste disposal, *Dredging, *Coastal waters, *Rehabilitation, *Spoil disposal, *Chesapeake Bay, Case studies, Fishing, Economic aspects, Project benefits.

The beneficial-use approach to open water dredged material disposal is a viable alternative both environmentally and economically to upland disposal for a wide spectrum of dredging projects. Using dredged material to create and rehabilitate habitats upon which many important fishery resources are dependent can be achieved with existing technology and within reasonable cost limitations. Small- to moderate-volume dredging projects using the beneficial-use concept in shallow coastal waters, as demonstrated at Twitch Cove and Slaughter Creek, can yield modest but appreciable cost savings and substantial long-term resources benefits. The Chesapeake Bay demonstration projects will be monitored to verify these benefits and document the results for future applications. (Lantz-PTT)
W89-06667

ENVIRONMENTAL INFORMATION DOCUMENT: BURNING/RUBBLE PITS,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5B.
W89-06676

CLEAN WATER ACT PERMIT GUIDANCE MANUAL,
Smith and Schnacke, Dayton, OH.
For primary bibliographic entry see Field 5G.
W89-06679

U.S. SLUDGE MANAGEMENT GUIDELINES EXPLAINED,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
L. Fradkin, R. J. F. Bruins, J. F. Stara, A. B. Rubin, and E. D. Lomnitz.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 9-12.

Descriptors: *Sludge, *Sludge disposal, *Policy making, *Risks, *Environmental Protection Agency, Public health, Decision making, Administrative regulations, Landfills, Incineration, Land application, Ocean dumping, Clean Water Act.

The EPA is developing comprehensive technical regulations under the Clean Water Act Section 405(d) on the reuse and disposal of municipal wastewater sludge. The reuse and disposal options are land application (including distribution and marketing), landfilling, incineration, and ocean disposal. Key questions to be addressed by EPA are identified and the tasks and major steps to pursue in answering these key questions are outlined. The EPA has developed a work plan for generating the technical regulations for reuse/disposal options; there are three tasks: (1) identification of pollutants of concern, (2) development of risk assessment methodologies, and (3) use of the outputs of tasks (1) and (2) to yield degrees of risk for specific applications and disposal rates. Documents aimed at summarizing the results of the three tasks will cover the following topics: fate and transport of pollutants, site-specific factors, economic evaluations and benefit analyses, compliance monitoring requirements, intermedia analysis, and description of data gaps. (See also W89-06705) (Rochester-PTT)
W89-06707

STATUS OF THE U.S. EPA'S SEDIMENT QUALITY CRITERIA DEVELOPMENT EFFORT,
Environmental Protection Agency, Washington, DC.
For primary bibliographic entry see Field 5G.
W89-06708

DEVELOPMENT OF NEW JERSEY STATE APPROVED METHODS FOR ANALYSIS OF SLUDGE,
New Jersey Dept. of Environmental Protection, Trenton. Bureau of Ground Water Quality Management.
For primary bibliographic entry see Field 5A.
W89-06720

USE OF GAS CHROMATOGRAPHY/MASS SPECTROMETRY TO MONITOR SELECTED PRIORITY POLLUTANT LEVELS IN LANDFILL SIMULATOR LEACHATES,
SCS Engineers, Inc., Covington, KY.
J. W. Stamm, J. J. Walsh, W. Jess, and J. I. Rickabaugh.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 148-158, 5 fig, 8 tab, 6 ref.

Descriptors: *Priority pollutants, *Landfills, *Wastewater analysis, *Leachates, *Pollutant identification, *Codisposal, Gas chromatography, Mass spectroscopy, Gel permeation chromatography, Isotope studies, Radioactive tracers, Sludge disposal, Monitoring, Simulated landfills.

Environmental emissions from 28 landfill simulators located at the EPA Test and Evaluation Facility in Cincinnati, Ohio, are being monitored in an effort to determine the impacts of disposing municipal wastewater treatment sludge to landfills. The landfill simulators contain mixtures of limes and anaerobically digested sludges, and municipal solid waste. One of the major goals of the program is to document and examine the release of six priority pollutants, which have been spiked into selected test cells. Leachate samples are analyzed by combined gas chromatography/mass spectrometry (GC/MS). Quantitation of the pollutant is accomplished using the isotope dilution technique. By adding a known amount of a labeled pollutant to a sample before extraction, correction for recovery of the pollutant can be made because the pollutant and its labeled analog exhibit the same effects from extraction, concentration, and gas chromatography. In addition, the method of gel permeation chromatography (GPC) is employed for sample purification. Preliminary findings indicate that pollutant release from codisposal test cells is not dissimilar from that seen in refuse-only cells. Use of the GPC technique has improved the percent recovery in the analysis of landfill simulator leachates. Obviously, further investigation is required since true environmental impact can be seen only through long-term monitoring. (See also W89-06705) (Author's abstract)
W89-06721

PERSPECTIVE ON RISK OF WATERBORNE ENTERIC VIRUS INFECTIONS,
Epidemiology Research Center, Tampa, FL. Dept. of Health and Rehabilitative Services.
F. M. Wellings.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 257-264, 2 tab, 28 ref.

Descriptors: *Waste disposal, *Sludge disposal, *Land disposal, *Risks, *Enteroviruses, *Wastewater treatment, Public health, Disinfection, Human diseases.

A valid perspective on the risk of waterborne enteric virus infections related to land disposal of sludge must incorporate various parameters. Interested parties, whether they are regulatory or scientific, should evaluate the whole through a careful examination of the parts. An attempt is made here to bring into focus the presently available data on four major virological issues: (1) characteristics of enteric viruses that enable them to survive wastewater treatment processes, (2) problems associated with the accumulation and interpretation of data related to viral contamination of groundwater by sludge disposal practices, (3) problems associated with transfer to the real world of data derived from laboratory-seeded experiments, and (4) problems related to the establishment of the role or enteric viruses in waterborne disease outbreaks. Present data are insufficient for establishing the quantitative risk of waterborne disease because of the land disposal of sludge. However, there is some probability of groundwater contamination sufficient to warrant a cautious approach to land disposal of sludge. (See also W89-06705) (Author's abstract)
W89-06729

MUTAGENIC POTENTIAL OF MUNICIPAL SEWAGE SLUDGE AND SLUDGE AMENDED SOIL,
Texas A and M Univ., College Station. Dept. of Soil and Crop Sciences.
For primary bibliographic entry see Field 5D.
W89-06733

STREAM IMPACT ASSESSMENTS USING SEDIMENT MICROBIAL ACTIVITY TESTS,
Wright State Univ., Dayton, OH. Dept. of Biological Sciences.
For primary bibliographic entry see Field 5A.
W89-06734

USE OF BENTHIC OXYGEN FLUX MEASUREMENTS IN WASTELOAD ALLOCATION STUDIES,
Environmental Protection Agency, Chicago, IL. Region V.
For primary bibliographic entry see Field 5A.
W89-06743

ANALYTICAL METHODS NECESSARY TO IMPLEMENT RISK-BASED CRITERIA FOR CHEMICALS IN MUNICIPAL SLUDGE,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
R. J. F. Bruins, L. Fradkin, J. F. Stara, W. B. Peirano, and V. Molak.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 465-471, 18 ref.

Descriptors: *Sludge disposal, *Risks, *Water quality standards, *Toxins, *Wastewater analysis, Land application, Ocean dumping, Landfills, Incineration, Sampling, Public health.

The Ambient Water Quality Criteria that were promulgated by the EPA in 1980 included water concentration levels that, for many pollutants, were so low as to be unmeasurable by standard analytical methods. Criteria for controlling toxics in municipal sludge likely would pose similar problems of sampling and analysis. Risk assessment methodologies recently developed by the EPA provide criteria derivation procedures for each of

the following sludge management practices: land application (including distribution and marketing), landfilling, incineration, and ocean disposal. These methodologies recommend that numerical limits on toxicant concentrations in sludge, or on rates of toxicant disposal, should be used to minimize risk to human health and the environment. Implementation of these numerical criteria would require refinement of sampling and analytical techniques for sludges, and various types of field validation studies would be needed to ensure that the criteria are appropriately protective. (See also W89-0) (Author's abstract)
W89-06744

REGULATION OF SLUDGE DISPOSAL THROUGH APPLICATION OF RISK ASSESSMENT TECHNIQUES,
ICF Technology, Inc., Richland, WA.
G. W. Dawson, C. J. English, and L. Fradkin.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 472-479, 6 fig, 1 tab, 6 ref.

Descriptors: *Waste disposal, *Sludge disposal, *Risks, *Administrative regulations, *Wastewater analysis, Landfills, Decision making, Algorithms, Model studies, Public health.

Risk-based methodologies are developed to establish criteria for regulating contaminant concentrations in sewage sludge for various disposal options. The risk-based approach used to develop contaminant criteria for regulation of sludge disposal is described, using landfill disposal as an example. The first tier analysis compares the results of an extraction test to health-based criteria. If the extract concentration for a contaminant is below the criteria, no further analysis is required. If the concentration exceeds the criteria, a tier 2 or 3 analysis is required. Tiers 2 and 3 are based on the application of analytical models to predict groundwater and vapor contaminant levels at the landfill property boundary. Tier 2 uses some site-specific data, such as hydraulic conductivity and soil type, along with literature values for adsorption and degradation. In Tier 3, site-specific field and laboratory studies are conducted to refine estimates of physical and chemical parameters affecting contaminant transport. The algorithms and models employed to simulate each element and the required input data are described. (See also W89-06705) (Author's abstract)
W89-06745

MICROBIOLOGICAL RISK ASSESSMENT FOR LAND APPLICATION OF MUNICIPAL SLUDGE,
Cincinnati Univ., OH. Dept. of Civil and Environmental Engineering.
P. V. Scarpino, L. Fradkin, C. S. Clark, N. E. Kowal, and E. Lomnitz.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 480-488, 2 fig, 5 tab, 9 ref.

Descriptors: *Waste disposal, *Sludge disposal, *Risks, *Pathogens, *Wastewater analysis, *Computer models, *Land application, Bacteria, Enteroviruses, Protozoans, Helminths, Fungi, Parasites, Public health.

A risk assessment methodology appropriate for pathogen risk evaluation for land application and distribution and marketing options was developed. A computer model was designed to aid in sludge management by comparing the risks of alternatives as sludge is applied to cropland and grazed pasture as a fertilizers and/or soil conditioner. The model integrates microbial dose-response information with the number of pathogens likely to be present in exposure pathways. Pathogens considered represent bacteria, parasitic helminths, and enteroviruses; representative parasitic protozoans and fungi were selected but were not included in the risk assessment due to lack of required data. The model covers eight sludge use pathways. Interpretations from risk assessment model outputs were made. (See also W89-06705) (Author's abstract)
W89-06746

TREATMENT AND USE OF SEWAGE EFFLUENT FOR IRRIGATION.
For primary bibliographic entry see Field 5D.
W89-06801

GUIDELINES FOR WASTEWATER REUSE IN AGRICULTURE,
Newcastle upon Tyne Univ. (England). Dept. of Civil Engineering.
For primary bibliographic entry see Field 3C.
W89-06803

QUALITY CRITERIA IN USING SEWAGE EFFLUENT FOR CROP PRODUCTION,
Food and Agriculture Organization of the United Nations, Rome (Italy). Land and Water Development Div.
For primary bibliographic entry see Field 3C.
W89-06804

ENVIRONMENTAL HAZARDS OF SEWAGE AND INDUSTRIAL EFFLUENTS ON IRRIGATED FARMLANDS IN JAPAN,
Tsukuba Univ. (Japan). Inst. of Applied Biochemistry.
T. Morishita.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 64-73, 9 tab, 2 fig, 8 ref.

Descriptors: *Wastewater, Industrial wastewater, *Wastewater irrigation, *Irrigation effects, *Water reuse, *Wastewater disposal, *Japan, Public health, *Environmental effects, Agriculture, Crop yield, Cadmium, Nitrogen, Rice, Water quality standards, Domestic wastes, Plant pathology, Wastewater treatment, Land disposal.

Very high water quality standards have been recommended for irrigation water in Japan. As long as the principle of 0% yield decrement for susceptible crops is maintained, the direct use of sewage or industrial effluents for crop irrigation will not be utilized. However, due to rapid industrial and urban growth the actual water quality is below the standards in some areas. Domestic wastewater drainage into the irrigation water is responsible for the major part of the present pollution in irrigated farmlands. Nitrogen and cadmium are the most critical hazards in the irrigated farmlands. Cadmium tends to accumulate in the soil surface layer and the rice plant has a high absorption capacity for cadmium and accumulates it in the grain. Excess nitrogen results in a rice yield loss through lodging, failure to ripen, and increased susceptibility to pests and diseases. The principal pollution control strategy is the basin-unit sewage disposal system, where the collected sewage and industrial wastes are treated in a centralized large-scale sewage disposal system located near the river mouth. Due to inefficiency, high cost, and water loss, research on land application systems are being studied. (See also W89-06801) (White-Reimer-PTT)
W89-06806

MEXICAN EXPERIENCE IN USING SEWAGE EFFLUENT FOR LARGE SCALE IRRIGATION,
Ministry of Agriculture and Water Resources, Mexico City.
For primary bibliographic entry see Field 3C.
W89-06818

PLANS FOR REUSE OF WASTEWATER EFFLUENT IN AGRICULTURE AND INDUSTRY IN THE KINGDOM OF SAUDI ARABIA,
Ministry of Agriculture and Water, Riyadh (Saudi Arabia). Water Research and Studies Div.
For primary bibliographic entry see Field 3C.
W89-06820

GROUND-WATER FLOW NEAR TWO RADIOACTIVE-WASTE-DISPOSAL AREAS AT THE WESTERN NEW YORK NUCLEAR SERVICE CENTER, CATTARAUGUS COUNTY, NEW YORK--RESULTS OF FLOW SIMULATION,
Geological Survey, Albany, NY. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06841

MAPS SHOWING GROUND-WATER UNITS, GROUND-WATER LEVELS, SPRINGS, AND DEPTH TO GROUND WATER, BASIN AND RANGE PROVINCE, IDAHO,
Geological Survey, Boise, ID. Water Resources Div.
For primary bibliographic entry see Field 7C.
W89-06874

MAPS SHOWING GROUND-WATER LEVELS, SPRINGS, AND DEPTH TO GROUND WATER, BASIN AND RANGE PROVINCE, NEW MEXICO,
New Mexico Bureau of Mines and Mineral Resources, Socorro.
For primary bibliographic entry see Field 7C.
W89-06875

THREE-DIMENSIONAL OPTIMIZATIONAL MODEL OF REGIONAL WASTEWATER TREATMENT PLANT SYSTEMS WITH APPLICATION TO THE UPPER PASSAIC RIVER,
Rutgers - The State Univ., New Brunswick, NJ. Graduate Program in Environmental Science.
For primary bibliographic entry see Field 5D.
W89-06921

MIGRATION OF RADIOACTIVE WASTES FROM SHALLOW LAND BURIAL SITE UNDER SATURATED AND UNSATURATED CONDITIONS,
Georgia Inst. of Tech., Atlanta. Div. of Graduate Studies in Health Physics.
For primary bibliographic entry see Field 5B.
W89-06923

STUDY OF THERMALLY INDUCED TIME-DEPENDENT CANISTER MIGRATION,
California Univ., Berkeley. Dept. of Civil Engineering.
H. D. Lin.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8624838. Ph.D. Dissertation, 1985. 234p, 117 fig, 11 tab, 56 ref, 6 append.

Descriptors: *Radioactive waste disposal, *Creep, *Sediment transport, *Bottom sediments, Mathematical models, Thermal properties, Hydrotherm studies, Migration, Computer programs, Computer models, Permeability coefficient, Ocean dumping.

A one-dimensional testing program for the study of long-term thermal consolidation of deep ocean sediments was developed in association with research into permanent repositories for high-level wastes. High temperature undrained creep tests at low stress levels of about 30 to 40% were conducted to study canister migration owing to undrained creep of surrounding sediments. An analytical model was developed for predictions of time-dependent canister migration owing to thermal loading and canister and sediment interaction. The model was implemented into an integral finite difference computer program (PILTM). The effects of temperature elevation accounted for in PILTM include thermal primary consolidation, thermal secondary compression, rebound, and elastic expansion. Additional laboratory tests on undisturbed smectite-rich soils are recommended, including low temperature tests to establish a complete set of data over the range of 4 to 200 C for analytical modeling. Tests should be conducted on thermal consolidation, undrained strength, and undrained creep over the same temperature range. (Cremmins-AEPCO)
W89-06926

GEOTOX: A KNOWLEDGE-BASED SURROGATE CONSULTANT FOR EVALUATING WASTE DISPOSAL SITES,
Lehigh Univ., Bethlehem, PA. Graduate School.
G. K. Mikroudis.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8705034. Ph.D. Dissertation, 1986. 316p, 47 fig, 48 tab, 179 ref, append.

Descriptors: *Artificial intelligence, *Waste disposal, *Hazardous materials, *Expert systems, *Knowledge bases, *Computer models, Decision making, On-site investigations, Sites, Systems analysis, Classification, Data processing, Data storage and retrieval.

GEOTOX, a surrogate consultant, knowledge-based system (KBS), was developed for the interpretation and diagnosis of environmental conditions at hazardous waste sites. The knowledge representation scheme in GEOTOX is based on an associative network of relationships among the various site parameters. Production rules are used at the leaf and conjunction nodes, but frames are attached to higher nodes of the network. The associative network represents the generic problem principles, the production rules represent the expert heuristics, and the frames represent expert-derived conclusions and situation descriptions at the site. GEOTOX uses a hazard index value and a confidence factor as provided by the expert rules and propagates them to all of the associated nodes following the link in the associative network. These values are combined with other preestablished values using an optimal Bayesian equation that statistically minimizes the error in the hazard index value. The inference mechanism provides a hazard score and a basis and point of reference to reason with deductions. Not just a supplement to the KBS and inference mechanism, GEOTOX is an integral part of the whole system for explaining the GEOTOX reasoning and justifying its conclusions. (Cremmins-AEPCO)
W89-06929

WASTEWATER APPLICATION TO SOILS: HYDRAULIC AND NITROGEN CONSIDERATIONS,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agronomy.
J. J. Simon.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8620666. Ph.D. Dissertation, 1986. 149p, 26 fig, 15 tab, 37 ref, 2 append.

Descriptors: *Wastewater irrigation, *Forages, *Textile mill wastes, *Hydraulic loading, *Soil treatment, Nitrogen, Leaching, Subsurface irrigation, Limestone, Clays, Nitrates, Absorption, Ponding, Pressure head, Nitrification.

Textile wastewater application to tall fescue resulted in maximum yield and plant uptake at 450 kg nitrogen (N)/ha, but standards for groundwater discharge were exceeded at the mid and high N levels. Temporal nitrate distribution data indicated substantial carryover of soil inorganic N could be expected for 1 year. Simple convective-dispersive solute leaching models predicted the nitrate-N distribution for the mid N level treatment but suggested further research to evaluate the timing of evaporation relative to infiltration under different precipitation or irrigation patterns. Clayey limestone-derived soils with moderate to strong structure were suitable for a septic tank subsurface absorption system (ST-SAS) at flux densities up to 2 cm/d. Where the bottom of the ST-SAS was less than 30 cm above a restrictive layer, ponding occurred and a biological clogging mat developed. Rapid nitrification was noted around an ST-SAS that drained to mean pressure heads less than -20 cm of water. In soils with mean pressure heads less than 0, nitrification was limited. Under these conditions, NH4(+) moved at least 1 m, indicating highly dispersive flow conditions. (Cremmins-AEPCO)
W89-06933

CHARACTERIZATION OF FLUID FLOW AND WASTEWATER TRANSPORT PROCESSES WITHIN A WISCONSIN-TYPE MOUND,
Purdue Univ., Lafayette, IN.
For primary bibliographic entry see Field 5D.
W89-06937

BIODEGRADATION OF ORGANIC CONTAMINANTS IN THE SUBSURFACE OF HAZARDOUS WASTE SITES,
Rice Univ., Houston, TX. Dept. of Environmental Science and Engineering.
M. D. Lee.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8617463. Ph.D. Dissertation, 1986. 160p, 25 fig, 40 tab, 149 ref.

Descriptors: *Biodegradation, *Path of pollutants, *Fate of pollutants, *Hazardous materials, *Organic wastes, *Microbial degradation, *Groundwater pollution, Water pollution control, Water pollution prevention, Biotransformation, Mineralization.

The ability of native organisms at three hazardous waste sites to degrade organic contaminants was studied. The extent that electron acceptors, inorganic nutrients, organic cosubstrates, and adapted microorganisms limited the rates and extent of biodegradation at the sites was investigated. Limited field investigations were conducted to identify limiting nutrients and the effects of their addition. Coefficients were derived to be applied to models describing the fate of chemicals at hazardous waste disposal sites. The sites consisted of an abandoned wood creosoting facility, where the silty sand aquifer was contaminated with polynuclear aromatic hydrocarbons; a sandy aquifer, where a spill of jet fuel polluted the groundwater with benzene, and toluene, and a site in which the fine sand aquifer was contaminated with benzene, toluene, naphthalene, and bis (2-chloroethyl) ether. Laboratory experiments at the creosoting facility revealed that the microbial population in the contaminated zone could degrade the pollutants, but the microorganisms were not found that could degrade the test compounds in the uncontaminated zone. At the third site, organisms in the uncontaminated zone were active against benzene, toluene, and to a lesser degree, naphthalene. (Cremmins-AEPCO)
W89-06957

MANAGING SALINE WASTE WATER FOR CROP PRODUCTION AND MINIMUM LEACHING,
California Univ., Riverside. Graduate Program in Soil Science.
For primary bibliographic entry see Field 3C.
W89-06963

DECOMPOSITION OF WASTEWATER ORGANICS IN SOIL,
North Carolina State Univ., Raleigh. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-06966

5F. Water Treatment and Quality Alteration

NUTRITIONAL VERSATILITY AND GROWTH KINETICS OF AN AEROMONAS HYDROPHILA STRAIN ISOLATED FROM DRINKING WATER,
Keuringsinstituut voor Waterleidingartikelen, Rijswijk (Netherlands).
D. van der Kooij, and W. A. M. Hijnen.
Applied and Environmental Microbiology AEMIDF, Vol. 54, No. 11, p 2842-2851, November 1988. 7 fig, 6 tab, 42 ref.

Descriptors: *Aeromonas, *Bacterial physiology, *Drinking water, *Growth kinetics, *Water treatment, *Water distribution, Microbiological studies, Kinetics, Organic compounds, Amino acids, Fatty acids, Growth, Glucose.

The nutritional versatility and growth kinetics of Aeromonas hydrophila were studied to determine the nature and the growth-promoting properties of organic compounds which may serve as substrates for the growth of this organism in drinking water during treatment and distribution. A total of 69 different organic compounds were tested at a concentration of 2.5 g/L as growth substrates. A mixture of 21 amino acids and a mixture of 10 long-chain fatty acids, when added to drinking water, promoted growth of strain M800 at individual compound concentrations as low as 0.1 ug C/L. Mixtures of 18 carbohydrates and 18 carboxylic acids clearly enhanced growth of the organism at individual compound concentrations above 1 ug C/L. Growth measurements with 63 individual substrates at a concentration of 10 ug C/L gave growth rates of > or = 0.1/h with two amino acids, nine carbohydrates, and six long-chain fatty acids. K sub s values were determined for arginine, glucose, acetate, and oleate. Data indicate that biomass components, such as amino acids and long-chain fatty acids, can promote multiplication of aeromonads in drinking water distribution systems at concentrations as low as a few ug/L. (Author's abstract)
W89-05799

OPERATING POLICIES FOR RESERVOIR PUMPED-WATER INTERTIES,
Ohio State Univ., Columbus. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3B.
W89-05821

WASTEWATER RECYCLING AND WATER CONSERVATION IN COMMERCIAL AND PUBLIC FACILITIES: CASE HISTORIES,
For primary bibliographic entry see Field 5D.
W89-05867

BIOLOGICAL REGENERATION OF NITRATE-LOADED ANION-EXCHANGE RESINS BY DENITRIFYING BACTERIA,
Wageningen Water Pollution Control Dept., Wageningen (Netherlands).
J. P. van der Hoek, A. B. Griffioen, and A. Klapwijk.
Journal of Chemical Technology and Biotechnology JCTBDC, Vol. 43, No. 3, p 213-222, 1988. 7 fig, 3 tab, 19 ref.

Descriptors: *Water treatment, *Anion exchange, *Resins, *Nitrates, *Denitrification, *Bacteria, Sludge, Brine disposal, Regeneration, Sodium chloride.

For regeneration of nitrate-loaded anion-exchange resins large quantities of salt are needed while the voluminous concentrated brine, produced during regeneration, is difficult to dispose of. These problems can be avoided by using denitrifying bacteria in the regeneration process of the resins. Experiments showed that resins could be regenerated by a denitrifying sludge suspension containing 7 g/cu dm NaCl. However, the process proceeded slowly compared with conventional regeneration. After 24 h of regeneration the resin still contained 18% nitrate relative to the total capacity. The breakthrough curve of a biologically regenerated ion-exchange resin was characterized by nitrate leakage whereas nitrate breakthrough started sooner, resulting in a nitrate capacity which was only 72% as compared with a conventionally regenerated ion-exchange column. (Author's abstract)
W89-05905

PROTECTING A WATER SYSTEM AGAINST BACKFLOW,
United McGill Corp., Columbus, OH.
D. Arthurs.
Consulting/Specifying Engineer CSENE9, Vol. 4, No. 4, p 78-81, October 1988. 3 fig, 1 tab.

Descriptors: *Sanitary engineering, *Water pollution prevention, *Water mains, *Backflow, *Hydraulic equipment, Hydraulic valves, Municipal water, Drinking water, Siphons, Accidents, Maintenance.

Backflow, the reversal of the normal flow of water through a water system, may occur wherever a

potential or structural connection exists between a water system and any other source or system of water or liquid. Backflow in a municipal water system is caused by either of two conditions: (1) backsiphonage--where the pressure in the drinking water system becomes less than atmospheric due to a vacuum or partial vacuum in that system; (2) backpressure--where the pressure in the nonpotable water system exceeds that in the drinking water system. It is estimated that 25% of all city water system cross-connections are unprotected from backflow. Such cross-connections can become problematic and endanger the quality of the potable water supply when an accident, sudden disruption in service due to broken pipes, water line maintenance, etc., causes a change in system pressure, allowing backflow to contaminate or pollute the water supply. Backflow preventers can eliminate this problem. These assemblies are of two general types: (1) double check valve assemblies--these should be used as protection for all direct or indirect water connections through which nonhazardous foreign materials might enter the system; (2) reduced pressure assemblies--these should be installed as protection for all direct or indirect connections were the system may be subject to backflow from toxic chemicals, sewage or other lethal substances. Many communities are in the process of setting up cross-connection programs to protect the drinking water supply. (Sand-PTT)
W89-05918

LOW-COST WATER AND SANITATION: TASKS FOR ALL THE PEOPLE,
International Reference Centre for Community Water Supply and Sanitation, The Hague (Netherlands).
D. Narayan-Parker.
World Health Forum WHFODN, Vol. 9, No. 3, p 356-360, 1988. 1 ref.

Descriptors: *Public health, *Sanitation, *Drinking water, *Developing countries, *Community development, *Indonesia, Surveys, Planning, Water quality, Coliforms.

Schemes for the provision of water and sanitation in urban fringe or rural communities of the Third World are unlikely to realize their full potential if they are put into effect by centrally directed engineers with little or no reference to local aspirations and preferences. Extensive consultation with the people who are going to use the services should take place from the outset, and women should figure prominently in the process. The practicalities of achieving this are considered in relation to a field study conducted in Indonesia. Fecal coliform counts from sources of water ranged from 0-5344/100 ml; the geometric mean was 17.7. For water in carrying containers the corresponding means for carrying containers and storage containers were 140.6 and 128.1. These findings, in addition to information on water-handling obtained through observation and during household interviews, clearly indicated that the way women and children were handling water contaminated it. There was a strong negative correlation between the presence of children aged 0-4 years in households and water quality. It was also observed that 78% of drinking water containers were kept within the reach of young children. Unless women and children to change the way they handle drinking water in the home, it will continue to be polluted despite improvements at the source. (Author's abstract)
W89-05924

NOVEL METHOD FOR LIBERATING VIRAL NUCLEIC ACID FOR ASSAY OF WATER SAMPLES WITH CDNA PROBES,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
For primary bibliographic entry see Field 5A.
W89-05944

IRON AND MANGANESE REMOVAL FROM A GROUNDWATER SUPPLY,
Arber (Richard P.) Associates, Inc., Denver, CO.
W. Lorenz, K. Seifert, and O. K. Kasch.
Public Works PUWOAH, Vol. 119, No. 12, p 57-58, November 1988. 3 ref.

Descriptors: *Iron, *Manganese, *Water treatment, *Groundwater, Cost analysis, Colorado, Planning, Filter media, Design criteria, Water treatment facilities, Capital costs.

The treatment options and planning techniques used by the town of Castle Rock (Colorado) for a new water treatment facility are described. Castle Rock officials assessed the available treatment options for dissolved iron and manganese removal and selected potassium permanganate as the primary oxidant to be followed by manganese greensand. A backup prechlorination system for oxidation was also installed. In addition, to prevent excess headloss buildup in the manganese greensand filter media, an anthracite carbon cap was used as the top filter medium for precipitate removal. It is recommended that a treatability study be performed to determine individual design criteria to allow for specific site conditions. The town also assessed the capital and operation and maintenance costs for both treatment at individual well fields and a centralized location for treatment of a cluster of well fields. The results indicate that it is more economical to provide centralized water treatment even though there are capital costs associated with piping raw water from the individual well fields to the central facility. (Miller-PTT)
W89-06009

DISJUNCTIVE KRIGING AS AN APPROACH TO MANAGEMENT DECISION MAKING,
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 6A.
W89-06073

DEVELOPMENT OF THE FLAVOR PROFILE ANALYSIS METHOD INTO A STANDARD METHOD FOR SENSORY ANALYSIS OF WATER,
Drexel Univ., Philadelphia, PA. Environmental Studies Inst.
For primary bibliographic entry see Field 5A.
W89-06101

RELATIONSHIP BETWEEN CONCENTRATION AND SENSORY PROPERTIES OF 2-METHYLISOBORNEOL AND GEOSMIN IN DRINKING WATER,
Osaka Prefecture Water Works Bureau (Japan). Water Testing Station.
For primary bibliographic entry see Field 5A.
W89-06102

CORRELATION BETWEEN THRESHOLD ODOR NUMBERS AND THE CONCENTRATION OF ODOROUS SUBSTANCES IN WATER,
Kyoto Municipal Water Works Bureau (Japan). Water Quality Lab.
M. Tomita, N. Ichikawa, and T. Goda.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 27-30, 1988. 4 fig, 5 ref.

Descriptors: *Odors, *Model studies, *Odor control, *Taste, *Water treatment, *Organoleptic properties, Organic compounds, Statistical analysis, Temperature, Algae, Cyanophyta, Alcohols, Hydrocarbons, Chlorine, Water quality.

A series of experiments was undertaken, using geosmin and 2- methylisoborneol (MIB) as test compounds, to ascertain the actual correlation between the threshold odor number (TON) and concentration of odorous substances in water. Fifteen replicates were provided for each sample, and the mean value of data from two experienced TON test experts was used to obtain the TON value. The relationship between the TON and the concentration of odorous substances for each sample was investigated by using least square methods, and goodness of fit to the Weber-Fechner Law and the Stevens Law was determined. The Stevens log-log model was found superior to the Weber-Fechner model for describing the relationship between TON and concentration. Addition of small amounts of citral or leaf alcohol to water with off-flavors was found to reduce the perceived TON significantly. This suggests the possibility of using such chemicals as masking agents for deodorization. Such treatment would be economically attractive, since the cost of adding these compounds to drinking water would be less than the cost of deodorization with powdered activated carbon. (Doria-PTT)
W89-06104

FLAVOR-PROFILE ANALYSIS: AN OBJECTIVE SENSORY TECHNIQUE FOR THE IDENTIFICATION AND TREATMENT OF OFF-FLAVORS IN DRINKING WATER,
Southern California Metropolitan Water District, La Verne. Water Quality Lab.
For primary bibliographic entry see Field 5A.
W89-06105

DETECTION OF TASTE AND ODOR IN OSAKA'S DRINKING WATER,
Osaka Prefecture Water Works Bureau (Japan). Dept. of Engineering.
For primary bibliographic entry see Field 5A.
W89-06106

POTENT ODOUR-CAUSING CHEMICALS ARISING FROM DRINKING WATER DISINFECTION,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
S. E. Hrudey, A. Gac, and S. A. Daignault.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 55-61, 1988. 2 fig, 2 tab, 31 ref.

Descriptors: *Odors, *Disinfection, *Water treatment, *Water pollution sources, *Drinking water, Organoleptic properties, Edmonton, Alberta, Organic compounds, Amino acids, Chlorination, Chromatography, Gas chromatography, Mass spectrometry, Pollutant identification, Rural areas.

A series of circumstantial observations surrounding transient but severe taste and odor incidents during the spring thaw in Edmonton suggested that a group of low-molecular-weight aldehydes may have been responsible for the problem. The literature indicated that these compounds have low detection thresholds and, as such, should have been readily detected in water supplies. The literature also suggested that some common amino acids could have provided the precursor for the aldehydes by reaction with the oxidants used for disinfection. Experiments were conducted that confirmed the ability of chlorine and chloramines to produce the odorous aldehydes. Unfortunately, no data were collected at the time of the events to determine amino acid concentrations in the raw water. However, a single sample of treated water at the time of the peak odor intensity showed a Total Kjehldahl Nitrogen of 1.45 mg/L, which is abnormally high for the North Saskatchewan River. Furthermore, the nature of the rural runoff would be expected to be enriched in amino acids. Amino acid concentrations previously reported in water treatment plants would be sufficient to produce odor problems if quantitatively oxidized. Considering all the evidence, there seems to be a reasonable possibility that transient odor problems may arise in water treatment plants which experience appropriate amino acid loadings in their raw water, or within their process as a result of biological activity, and which provide appropriate oxidation conditions with either chlorine or chloramines. The specific oxidation conditions which affect this process remain to be determined and are currently under investigation. (Doria-PTT)
W89-06109

SIMPLE EXTRACTION PROCEDURE FOR MODERATELY VOLATILE TASTE AND ODOR COMPOUNDS SUCH AS GEOSMIN AND 2-METHYLISOBORNEOL: METHOD AND APPLICATIONS,
National Water Research Inst., Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W89-06113

ODOR DECOMPOSITION BY THE YEAST CANDIDA,
Kyoto Univ. (Japan). Dept. of Environmental and Sanitary Engineering.
H. Sumitomo.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 157-162, 1988. 8 fig, 6 ref.

Descriptors: *Yeasts, *Decomposition, *Biological treatment, *Water treatment *Odor control, Odors, Organoleptic properties, Metabolism, Microbiological studies, Filters, Alcohols, Plastics, Glucose, Sand filters.

Several microorganisms that can decompose 2-methylisoborneol (MIB) were isolated from a slow sand filter. A yeast (Candida sp.) with rather limited ability to decompose MIB was used as an effective microorganism because of its safety and convenience of handling in the laboratory. After measuring the ability of the yeast to decompose MIB in a liquid medium, it was immobilized in a gel produced from 10% polyvinyl alcohol (PVA). Several materials, such as plastic and glass, were coated with the immobilized yeast, and were used in experiments on the decomposition of MIB. MIB was decomposed by the gel, which demonstrated that Candida continued to grow in the PVA gel, judging from the amount of MIB decomposed. (Doria-PTT)
W89-06121

ODOR DECOMPOSITION BY AN IMMOBILIZED CRUDE ENZYME,
Kyoto Univ. (Japan). Dept. of Environmental and Sanitary Engineering.
H. Sumitomo, Y. Ohmura, S. Ito, and R. Takaya.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 163-166, 1988. 7 fig, 5 ref.

Descriptors: *Odor control, *Decomposition, *Enzymes, *Water treatment, *Yeasts, Odors, Organoleptic properties, Proteins, Glucose, Alcohols, Filters, Isolation, Sand filters.

A crude enzyme or protein which can decompose 2-methylisoborneol (MIB) was isolated by ultrasonic methods from a yeast (Candida sp.). The ability of this enzyme to decompose MIB was investigated under different chemical conditions and the effects of glucose, ethanol, and adenosine 5'-triphosphate (ATP) on this decomposition reaction were tested empirically. The crude enzyme was immobilized in a polyvinyl alcohol (PVA) disk, which was used to study the decomposition of MIB at the laboratory scale. Since the PVA gel was rather soft and limp, seven sheets of the gel were fixed between wire nets to form a rotating disk system. In one experiment, ATP (0.41 mM) and glucose (1 g/L) were added to the inorganic liquid medium, and disks were rotated at high speed (120 rpm). It was found that the immobilized crude enzyme could decompose MIB to a small extent in natural (lake) water without ethanol. (Doria-PTT)
W89-06122

BACTERIAL DEGRADATION OF 2-METHYLISOBORNEOL,
Southern California Metropolitan Water District, La Verne. Water Quality Branch.
G. Izaguirre, R. L. Wolfe, and E. G. Means.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 205-210, 1988. 2 fig, 23 ref.

Descriptors: *Odor-producing algae, *Bacteria, *Biodegradation, *Odors, *Water treatment, Organoleptic properties, Isolation, Microbiological studies, Growth media, Reservoirs, Sediments.

2-Methylisoborneol (MIB) is a musty-odored compound occurring in natural waters that is difficult to remove by conventional water treatment methods. Biodegradation may be an alternative for its removal from drinking water. Studies were undertaken to determine the conditions enhancing MIB degradation and to isolate and identify the bacteria responsible. MIB degraders were enriched using mg/L levels of the compound, in a defined mineral medium, inoculated with water and sediment samples from reservoirs where MIB is seasonally produced. Cultures that degraded MIB were isolated and enumerated. Degradation occurred only in mixed cultures. MIB supported growth as sole carbon source at 1-6.7 mg/L. MIB at 10 micrograms/L was also degraded in sterile lake water inoculated with washed bacteria. The degradation of MIB at both micrograms/L and mg/L levels took from 7 days to more than 2 weeks. Despite the relative recalcitrance of MIB, degradation occurred in cultures representing a variety of lake-water and sediment samples, indicating widespread occurrence of potential MIB degraders in reservoirs in which MIB is produced. Thus, the potential exists for in situ degradation of MIB in these reservoirs by indigenous bacteria. How this process might be enhanced is a practical question still unanswered. (Author's abstract)
W89-06128

OVERVIEW OF TECHNOLOGY FOR CONTROLLING OFF-FLAVORS IN DRINKING WATER,
Southern California Metropolitan Water District, La Verne.
M. J. McGuire, and J. M. Gaston.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 215-228, 1988. 2 fig, 2 tab, 61 ref.

Descriptors: *Taste, *Water treatment, *Water analysis, *Odor control, Organoleptic properties, Reviews, Drinking water, Aeration, Oxidation, Activated carbon, Biological treatment, Reservoirs, Ozone, Chemical analysis, Water quality management, Filtration, Odors, Technology.

Treatment methods for controlling off-flavors in drinking water are reviewed. A three-pronged attack on off-flavor problems in drinking water is suggested that consists of (1) analytical methods, (2) source control, and (3) treatment. Sensory and/or chemical analytical methods are crucial to the success of any control strategy. Without at least one reliable analytical method, source control will be difficult, if not impossible, and hit-and-miss treatment will result. Many utilities are finding flavor profile analysis and closed-loop stripping analysis to be reliable tools in dealing with off-flavor problems. Source control is also important, as it is usually cheaper than chemical treatment. For utilities that can control their source of supply, treatment may not be necessary. Also, treatment processes can be overwhelmed if source control is not practiced. At the very least, an early warning system should be in place to warn treatment plant operators to adjust chemical dosages or institute new treatment procedures. The most effective treatment processes for the control of off-flavors are powdered activated carbon and granular activated carbon. Ozone at higher dosages and advanced oxidants (such as ozone/hydrogen peroxide) have shown excellent potential for controlling even 2-methylisoborneol and geosmin. Widespread use of advanced oxidation processes will have the dual benefit of controlling trihalomethanes and producing drinking water with few, if any, off-flavor problems. (Author's abstract)
W89-06130

PILOT SCALE STUDIES OF GEOSMIN AND 2-METHYLISOBORNEOL REMOVAL,
Aquateam-Norwegian Water Technology Centre of Oslo (Norway).
E. A. Vik, R. Storhaug, H. Naes, and H. C. Utkilen.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 229-236, 1988. 5 fig, 1 tab, 13 ref.

Descriptors: *Water treatment, *Cyanophyta, *Pilot plants, *Odor control, Taste, Odors, Organoleptic properties, Oscillatoria, Algae, Activated carbon, Ozonation, Filtration, Filters, Eutrophication, Organic compounds.

Water blooms of Oscillatoria bornettii, a producer of off-flavor compounds, occasionally occur in Lake Mjoesa in Norway. A new water works is planned to alleviate the associated taste and odor problems. A pilot plant was constructed in 1985 and a continuous water treatment study was performed over a one-year period. Granular activated carbon (GAC) was compared with ozonation-GAC. Filtrasorb-400 was used and the empty-bed contact-time of the GAC-filters was 21 min. The ozone dosage varied from 2 to 5 mg O3/L. To simulate water blooms, commercially produced geosmin and 2-methylisoborneol (MIB) were added to the water in concentrations from 10 to 190 ng/L. Large variations in the concentration of geosmin and MIB were demonstrated in both treatment lines. However, the threshold odor limit was exceeded for both compounds several times. The GAC-process showed better geosmin and MIB removal than the ozonation-GAC combination. This could be interpreted as indicating that the ozonation process was forming organic oxidation products that were competing with the geosmin and MIB for adsorption sites on the GAC. This phenomenon is currently being studied. A slightly higher total organic compound (TOC) uptake was observed on the ozonation-GAC treatment line compared to the GAC treatment line. The saturation of the GAC-columns with TOC was seen after 8,000 bed-volumes on both treatment lines. The possible effect of residual ozone on the treatment efficiency of the GAC filters is being studied by placing a post ozone contactor detention basin before the GAC-columns. (Author's abstract)
W89-06131

WATER TREATMENT SYSTEMS AND TECHNOLOGY FOR THE REMOVAL OF ODOR COMPOUNDS,
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
K. Hattori.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 237-244, 1988. 7 fig, 5 tab, 15 ref.

Descriptors: *Water treatment, *Odor control, Technology, Odors, Organoleptic properties, Lake Biwa, Japan, Filtration, Activated carbon, Ozonation, Biological treatment, Organic carbon.

Compounds responsible for a musty odor in Lake Biwa (Japan) include 2-methylisoborneol (MIB) and geosmin. The rapid sand filtration system normally in use has a low efficiency for the removal of such odor compounds, so a study of the following removal technologies was undertaken: powdered and granular activated carbon (PAC, GAC), ozone, and bio-film. PAC treatment gave poor results and is not a viable solution, as the length of odor occurrence is excessive for such a treatment. In postozonation, the necessary dosage for the removal of odors below the detection threshold odor concentration was more than 3 mg/L. Furthermore, complicated operation conditions are needed, since the effective concentration of ozone depends on the water conditions. In addition, ozonation can produce new odorous substances. Therefore, many practical problems are involved with the use of ozone. Bio-film contact oxidation removed geosmin, but not MIB. However, this treatment had an excellent effect on other contaminants, especially ammonium nitrogen. GAC treatment was the most effective treatment, although when the removal rate of organic carbon by GAC dropped to 30%, the odor was not removed. However, GAC is able to remove odor compounds completely, even if the time period of odor occurrence is about 40 days during a year. (Doria-PTT)
W89-06132

FORMATION AND REMOVAL OF OFF-FLAVOUR COMPOUNDS DURING OZONATION AND FILTRATION THROUGH BIOLOGICALLY ACTIVE SAND FILTERS,
Linkoeping Univ. (Sweden). Dept. of Water in Environment and Society.
B. V. Lundgren, A. Grimvall, and R. Savenhed.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 245-253, 1988. 3 fig, 2 tab, 18 ref.

Descriptors: *Odor control, *Taste, *Biological filters, *Ozonation, *Filtration, *Water treatment, Organoleptic properties, Filters, Chromatography, Gas chromatography, Organic compounds, Oxygen requirements.

Formation and removal of off-flavor compounds during ozonation and during filtration through bio-

logically active sand filters were evaluated by gas chromatography and column sniffing. A well aerated sand filter (0.5 m deep) with a water flow rate of 25 mm/h was able to produce an almost odorless water from a raw water with a strong muddy and earthy off-flavor. Frequently occurring off-flavor compounds, such as geosmin, 2-methylisoborneol, 2,4,6-trichloroanisole, 1-octen-3-one, and dimethyl trisulfide, were all effectively removed, provided the oxygen supply was sufficiently high. The removal of color, however, was not satisfactory. Treatment with ozone removed the color of the water and caused a dramatic change in odor quality. Certain off-flavor compounds, such as geosmin and 2-methylisoborneol, decreased in concentration, while several other off-flavor compounds, such as octanal, increased in concentration. The ozonation by-products were only partly removed during sand filtration, and the filter effluent had a weak, but noticeable, off-flavor. Chromatographic sniffing indicated that some of the ozonation by-products were, in fact, less amenable to biodegradation than the off-flavor compounds that were removed by ozonation. (Author's abstract)
W89-06133

BIOLOGICAL DEGRADATION OF MUSTY ODOR COMPOUNDS, 2-METHYLISOBORNEOL AND GEOSMIN, IN A BIO-ACTIVATED CARBON FILTER,
Okayama Univ., Kurashiki (Japan). Inst. for Agricultural and Biological Sciences.
M. Yagi, S. Nakashima, and S. Muramoto.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 255-260, 1988. 1 fig, 4 tab, 7 ref.

Descriptors: *Biodegradation, *Odor control, *Activated carbon, *Biological filters, *Water treatment, Filters, Filtration, Bacteria, Bacillus, Cyanophyta, Algae, Sand, Sand filters.

A study was undertaken to confirm the degradation of musty odor compounds by some bacteria attached to activated carbon. Raw water samples were drawn through an activated carbon column and musty odor compounds on the carbon were extracted and analyzed by gas chromatography. The concentration of 2-methylisoborneol (MIB) in the filtrates from bio-activated columns inoculated with Bacillus subtilis was < 0.06 mg/L in the first experiment and < 0.16 mg/L in the second. In the control activated carbon, MIB was reduced to less than the detection limit (0.01 mg/L) in each portion of the filtrate. Therefore, a slight breakthrough of musty odor compounds seems to occur with bio-activated carbon filters but not with activated carbon filters. The ratio of biodegradation to loading was 56% for MIB and 72% for geosmin. In the control filter, 25% of MIB was degraded. This value is unusually high, and suggests that the control filter may be contaminated by bacteria. Several filter materials were compared for ease and effectiveness in the preparation of bio-activated carbon filters. The adsorption of bacteria on filters of sand or zeolite was insufficient under the experimental conditions used. (Doria-PTT)
W89-06134

BEHAVIOR OF MUSTY ODOROUS COMPOUNDS DURING THE PROCESS OF WATER TREATMENT,
Osaka Prefecture Water Works Bureau (Japan). Water Examination Lab.
K. Ashitani, Y. Hishida, and K. Fujiwara.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 261-267, 1988. 2 fig, 5 tab, 8 ref.

Descriptors: *Odor-producing algae, *Odor control, *Water treatment, *Cyanophyta, Algae, Coagulation, Sedimentation, Sedimentation basins, Chlorination, Pilot plants, Activated carbon, Chlorine, Residual chlorine, Filtration, Filters, Sand filters.

Geosmin and 2-methylisoborneol (MIB) are two of the causative compounds responsible for the musty odor problem in drinking water. Geosmin and MIB in raw water at Osaka, Japan were present both in solution and in a suspended form mostly associated with the host cyanobacteria. Geosmin and MIB in suspended form were well removed by coagulation and sedimentation alone. Geosmin present in solution could be removed almost to an undetectable level in the rapid sand filter of a pilot plant where no pre-chlorination was practiced. Breakpoint pre-chlorination, however, forced geosmin and MIB present inside the host algae to leak into the water. The concentration of MIB decreased in a sedimentation basin during the daytime, but not at night in the plant practicing breakpoint pre-chlorination. Geosmin and MIB were both decomposed under sunlight in the presence of free residual chlorine. (Author's abstract)
W89-06135

OFFENSIVE TASTES AND ODORS OCCURRING AFTER CHLORINE ADDITION IN WATER TREATMENT PROCESSES,
Compagnie Generale des Eaux, Paris (France). Centre de Recherche.
Y. Levi, and J. M. Jestin.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 269-274, 1988. 1 fig, 3 tab, 7 ref.

Descriptors: *Odors, *Taste, *Chlorination, *Water treatment, *Drinking water, Organoleptic properties, Chlorine, Paris, France, Water quality, Hydrocarbons, Chlorinated hydrocarbons, Biological treatment, Chromatography, Electron capture gas chromatography, Ozonation.

To identify and eliminate the causes of tastes and odors in drinking water, a new methodology for absolute threshold flavor determination was developed, called 'up-and-down.' A study was undertaken at an important biological treatment plant in a suburb of Paris over a period of one year to compare results from physicochemical analyses with those of up-and-down threshold (UDT) values. This work also demonstrated the very important influence of chlorination on water quality. A number of physicochemical parameters like purgeable and total organic halogens and trihalomethanes were shown to be unsuitable for the prediction of UDT values, but chromatographic finger printing after closed-loop stripping analysis extraction and electron capture detection showed a possible relationship with UDT. Processes involving dechlorination, stripping, and ozonation have been developed to remove chlorine-like odors from treated water supplied. (Author's abstract)
W89-06136

REDUCTION OF MUSTY ODOR SUBSTANCES IN DRINKING WATER: A PILOT PLANT STUDY,
Osaka Prefecture Water Works Bureau (Japan). Kunijima Purification Plant.
K. Terashima.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 275-281, 1988. 14 fig, 9 ref.

Descriptors: *Odor control, *Pilot plants, *Water treatment, *Ozonation, *Chlorination, *Activated carbon, Drinking water, Ozone, Filters, Sand filters.

The reduction of the musty odor substances 2-methylisoborneol (MIB) and geosmin was investigated using a 60 cu m/day scale pilot plant. The ozone dose rate of 2-5 mg/L was sufficient for the reduction of MIB and geosmin, and their reduction rates were between 75-100%. Two rapid sand filtrates, one pre-chlorinated and the other not pre-chlorinated, were introduced to the granular activated carbon (GAC) filters. Depending on which influent was used, the reduction rates were different and the GAC filter which filtered the water without pre-chlorination maintained its effectiveness in removing MIB and geosmin longer than the other. On the basis of these results, a 2,000 cu m/day scale demonstration plant was constructed. The results of one year's operation demonstrated the effectiveness of the method in removing musty odor substances from a large city water supply. (Author's abstract)
W89-06137

AQUATIC OFF-FLAVOURS: PAST, PRESENT AND FUTURE,
Helsinki Univ. (Finland). Dept. of Limnology.
For primary bibliographic entry see Field 5A.
W89-06138

MATHEMATICAL MODELLING OF TRANSIENT BEHAVIOUR OF DEEP BED FILTRATION,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-06183

PHOTOMETRIC METHOD FOR THE DETERMINATION OF LOW CONCENTRATIONS OF HYDROGEN PEROXIDE BY THE PEROXIDASE CATALYZED OXIDATION OF N,N-DIETHYL-P- PHENYLENEDIAMINE (DPD),
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
H. Bader, V. Sturzenegger, and J. Hoigne.
Water Research WATRAG, Vol. 22, No. 9, p 1109-1115, September 1988. 5 fig, 1 tab, 34 ref.

Descriptors: *Hydrogen peroxide, *Drinking water, *Photometry, *Water treatment, Pollutant identification, Oxidation, Ozonation, Chlorination, Spectrophotometry, Water analysis.

The concentration of hydrogen peroxide (H2O2) in distilled water, drinking water and in different types of surface and rain waters can be easily determined by a photometric method in which N,N-diethyl-p-phenylenediamine (DPD) is oxidized by a peroxidase catalyzed reaction. DPD is available as a commercial reagent. In all waters its oxidation occurs with a stoichiometric factor of 2.0 and leads to an absorbance (at 551 nm) of 21,000 + or - 500/M/cm per H2O2. In the presence of other hydro-peroxides H2O2 can be determined by comparison with a blank in which the H2O2 is destroyed with sulfite, and the sulfite residual masked with formaldehyde. The detection limit is 0.2 micrograms/L in distilled water and about 0.3 micrograms/L in most types of natural waters when 10 cm cells and a spectrophotometer are used. The DPD method is considered to be a candidate for a standard method for drinking water analysis because it is easy to perform and to calibrate for absolute determinations. (Author's abstract)
W89-06185

EVALUATION OF A CHLORAMINE DECOMPOSITION MODEL INCORPORATING GENERAL ACID CATALYSIS,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
R. L. Valentine, C. T. Jafvert, and S. W. Leung.
Water Research WATRAG, Vol. 22, No. 9, p 1147-1153, September 1988. 13 fig, 2 tab, 19 ref.

Descriptors: *Chlorination, *Chloramines, *Trihalomethanes, *Decomposition, *Water treatment, *Chlorine, Model studies, Ammonia, Phosphates, Catalysts, Silicates, Carbonates, Disinfectants.

An existing model describing the slow decomposition of chloramines in the presence of excess ammonia was modified to incorporate general acid catalysis of monochloramine disproportionation, a key reaction in determining the rate of chloramine loss. Experiments were conducted at various reaction conditions in the presence of varying concentrations of phosphate which was used as an analog for other naturally occurring proton donors. Results were used to obtain an estimate of the specific rate constant characterizing the effect of H2PO4(-) and to demonstrate the validity of the overall model formulation. Measured chloramine concentrations compared favorably with predicted values indicating that inclusion of the catalytic effect on monochloramine disproportionation alone appears justified in assessing the effect of phosphate. By analogy, it is expected that similar inorganic proton donors such as those of carbonate and silicate would also potentially affect only monochloramine disproportionation and that the modified model should be better able to assess chloramine decay in natural waters. (Author's abstract)
W89-06190

CONSEQUENCES OF THE MASS BALANCE SIMPLIFICATION IN MODELLING DEEP FILTRATION,

Krakow Technical Univ. (Poland). Faculty of Sanitary and Environmental Engineering.
W. Dabrowski.

Water Research WATRAG, Vol. 22, No. 10, p 1219-1227, October 1988. 12 fig, 15 ref.

Descriptors: *Water treatment, *Filtration, *Mathematical models, *Deep filtration, Mass balance, Chlorella, Errors, Accuracy, Head loss, Suspended solids.

Mathematical modeling of deep filtration has seldom been used in water treatment technology, mainly because of the nonhomogeneity of flocs resulting from chemical pretreatment of raw water. This does not mean, however, that mathematical methods of modeling are not applied in research on complex processes accompanying the suspension flow through a filter bed. The mass balance equation is usually used in an approximate form obtained after omission of the term describing the time gradient of solids in suspension flowing through the pores of the medium. The errors of mathematical modeling of deep filtration resulting from mass balance simplification were investigated. Published data on filtration experiments with algae (Chlorella) were used to estimate the discrepancies of computations resulting from approximation of the mass balance equation. Inequalities were used to limit the solution of the complete filtration equations. The specific deposit, head loss and mean concentration of suspension were restricted by over- and under-functions. The over-function was due to the solution of the filtration equation with the approximated form of the mass balance equation and some under-functions were constructed on the basis of the equations being analogous to the Herzig-Leclerc-Le Goff equations. In this way the connections between time, depth, and computation errors were tested. It was confirmed that the mass balance simplification has no significant influence on the accuracy of calculations of head loss and mean concentration of suspension. (Rochester-PTT)
W89-06217

FILTER PORE FLOCCULATION AS A MECHANISM IN RAPID FILTRATION,

Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
N. J. D. Graham.

Water Research WATRAG, Vol. 22, No. 10, p 1229-1238, October 1988. 14 fig, 18 ref.

Descriptors: *Rapid filtration, *Model studies, *Water treatment, *Filters, *Filtration, *Computer models, *Flocculation, Model studies, Performance evaluation, Comparison studies, Kaolin, Cationic polymers, Simulation, Prediction.

The process of particle capture in a clean rapid filter was simulated using a computer model that incorporates the mechanisms of filter pore particle flocculation. the results of filtration simulations highlighted the importance of the particle-particle collision efficiency factor and predict that under typical filtration conditions orthokinetic flocculation of particles in filter pores can be significant. However, the consequent improvement in filter performance as expressed by the filter coefficient is small. Comparative laboratory filtration experiments using kaolin suspensions destabilized with a cationic polymer suggest that filter pore flocculation effects are greater than predicted by computer simulation. (Author's abstract)
W89-06218

MICROBIAL METABOLISM OF CYANOBACTERIAL PRODUCTS: BATCH CULTURE STUDIES WITH APPLICATIONS TO DRINKING WATER TREATMENT,

Alberta Univ., Edmonton. Dept. of Microbiology.
P. M. Fedorak, and P. M. Huck.

Water Research WATRAG, Vol. 22, No. 10, p 1267-1277, October 1988. 8 fig, 2 tab, 30 ref. National Research Council (Canada) Contract 31949-6-005/01-SZ.

Descriptors: *Water quality, *Microbiological studies, *Cyanophyta, *Metabolites, *Water treatment, Anabaena, Photosynthesis, Mineralization, Radioactive tracers, Tracer studies, Algae, Eutrophication, Buffalo Pound Lake, Saskatchewan, Drinking water sources, Isotope studies, Culturing techniques, Organic carbon removal, Batch culture, Metabolism.

Cultures of the cyanobacterium Anabaena flos-aquae were grown in the presence of C-14 labeled HCO3 (-) to produce labeled products, which were fractionated to give soluble intracellular and extracellular materials and insoluble particulate materials. These fractions were used as substrates in batch mineralization studies. Water samples from Buffalo Pound Lake (Saskatchewan, Canada), a eutrophic source of drinking water, were used as the source of the heterotrophic microbes. The heterotrophs typically oxidize over 65% of the labeled soluble products to 14CO2. The particulate materials from A. flos-aquae cultures were less amenable to mineralization and the mean proportion of label recovered as 14CO2 was 43%. Before mineralization, the apparent molecular weight (AMW) of the majority of the A. flos-aquae extracellular material was between 1000 and 3000 daltons. Heterotrophic metabolism yielded higher AMW materials and late-eluting, presumably lower AMW, materials. Samples collected from Buffalo Pound Lake during the annual cyanobacterial bloom were incubated in the presence of C-14 labeled HCO3(-). Experiments with these soluble labeled products showed that they were mineralized to the same extent as the A. flos-aquae products and that high AMW material remained. The present results show that the photosynthesized soluble products of cyanobacteria are readily mineralized by heterotrophic microorganisms and that microbiological pretreatment of raw water should reduce the total organic carbon concentration in a drinking water. (Author's abstract)
W89-06223

INFLUENCE OF METAL IONS RELEASED BY AN ACTIVATED CARBON ON THE ADSORPTION OF ORGANICS: THE ROLE OF CALCIUM IONS (INFLUENCE DES IONS METALLIQUES LIBERES PAR UN CHARBON ACTIF SUR L'ADSORPTION DE MICROPOLLUANTS ORGANIQUES: LE ROLE DES IONS CALCIUM),

Limoges Univ. (France). Lab. de Genie Chimique, Traitement des Eaux.
M. Mazet, A. Yaacoubi, and P. Lafrance.

Water Research WATRAG, Vol. 22, No. 10, p 1321-1329, October 1988. 11 fig, 3 tab, 26 ref. English summary.

Descriptors: *Calcium, *Water treatment, *Cations, *Activated carbon, *Adsorption, *Sodium lauryl sulfate, *Chemical water treatment, Kinetics, Electrostatic interactions, Surfactants.

Calcium ions have been shown to significantly increase the adsorption of organics or micropollutants found in water supplies onto activated carbon. An attempt was made to quantify the effect of calcium ion concentration on the adsorptive capacity of a powdered activated carbon (PAC) for sodium lauryl sulfate (LS). Measurements of sorption kinetics of LS were made using a PAC treated in three ways: (1) untreated, (2) washed with distilled water before use, and (3) washed with 1N HCl before use. Washing the PAC before conducting an adsorption study diminished the effectiveness of the PAC in removing LS. These results may be related to the surface ionic content of the PAC, especially the calcium content: the untreated PAC may contain 50 micromol Ca(2+)/g of carbon, whereas the PAC washed with distilled water released 42 micromol Ca(2+)/g of carbon and the PAC washed with 1N HCl released 75 micromol Ca(2+)/g of carbon. Decreasing the molar ratio of LS/Ca(2+) caused an increase in the removal of the LS. The influence of the order of mixing of the adsorbates LS and Ca(2+) with PAC was demonstrated using sorption kinetic curves. Results indicated that the residual concentration of LS in solution was not affected by the order of mixing adsorbates and PAC when the molar ratio of LS/Ca(2+) is 1.0. Such results support the assumption that calcium ions specifically interact with the carbon surface to increase the adsorption of LS. The electrostatic interactions between PAC and Ca(2+) were examined by zeta potential measurements of the PAC. Whereas micromolar concentrations of LS caused a marked reduction in the negative surface charges of the PAC, Ca(2+) induced a rapid neutralization of the zeta potential. Neutralization of negative functional groups is strongly related to the increase of the maximum adsorption capacity of the PAC for LS. The role of Ca(2+) in adsorption of LS indicates that the carbon efficiency in removing anionic compounds can be improved significantly by the addition of micromolar quantities of salt in solution. (Author's abstract)
W89-06230

WATER RESOURCES DEVELOPMENT, MANAGEMENT AND QUALITY CONTROL IN ILORIN METROPOLIS, NIGERIA,

Ilorin Univ. (Nigeria). Dept. of Geography.
R. O. Oyegun.

Aqua AQUAAA, No. 5, p 233-240, 1988. 4 fig, 7 tab, 15 ref.

Descriptors: *Water management, *Nigeria, *Water supply systems, *Water quality control, *Water treatment facilities, *Water resources development, Human population, Operating policies, History, Ilorin.

The characteristics of the Ilorin, Nigeria, water supply system are described, including: population growth in the service area, Asa Dam and catchment area, rainfall and discharge in the catchment, the distribution system, the treatment plant, quality control, and contaminants in the water (organic pollutants). Water resources are abundant in Ilorin, but the city often experiences water shortages. Water development is progressing behind schedule and management of what exists is poor, because of unskilled personnel and financial constraint. Some areas of the town have no water at because of topography and distance from the gravity-powered reservoirs. Water quality is not always good. Reasons for the poor management and quality of the Ilorin water supply. Certain chemicals such as chlorine show a decreasing gradient in concentration from the treatment plant to the stand pipes within the city. Monitoring points along the distribution mains to boost the concentration of necessary chemicals in domestic supply or at least, their concentration at the treatment plant should be increased. (Rochester-PTT)
W89-06233

ECONOMICAL SAFEGUARDING OF WATER SUPPLY: THE WATER PRICE,

Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.).
H. Gundermann.

Aqua AQUAAA, No. 5, p 241-248, 1988. 10 fig.

Descriptors: *Water supply, *Economic aspects, *Management planning, *Pricing, Water demand, Projections, Investment, Water quality, West Germany, Water costs, Utilities.

The importance of the water price in utility planning is discussed. The price of water is the decisive instrument for the long-term safeguarding of revenues, but remains too much a 'matter of politics.' Only economically sound water supply systems are able to provide sufficient quantity and quality of drinking water at any time. More than other branches of industry, the public water supply utility has to rely on a long-term forecast indicating all technical and economic data. The influence of factors of the water demand are much more difficult to judge than the demand itself. The expected population trend plays an important part in planning water demand. Investments are necessary whether the utility is delivering more water or not. Acquiring good quality water may necessitate additional investments that result regularly in jumps of prices. The principle of prime-costs reimbursement has been introduced widely into price calculation for water supplies. The principle is as follows: the more cost and price structure correspond

to each other, the higher the quantity for which revenues and costs reach the break-even point. This discussion of water pricing uses examples from West Germany. (Rochester-PTT)
W89-06234

AUTOMATION AND CONTROL: GENERAL CONCEPTS AND THEIR APPLICATION IN WATER SUPPLY AND WASTE DISPOSAL SYSTEMS,
M. Garcia Poveda.
Aqua AQUAAA, No. 5, p 249-253, 1988.

Descriptors: *Automation, *Control systems, *Water supply systems, *Sewer systems, Network design, Telemetry, Design criteria, Management planning, Data processing, Information systems, Computers, Operating policies, Systems analysis, Project planning.

Automation and control systems as employed in water supply and sewer systems are discussed, including the following topics: definitions of automatic systems, characteristics of water supply and sewer systems that make automation necessary, objectives of automation and precautions, detecting and actuating devices, analog and digital telemetry, transmission lines, design (architecture) rules for automation systems, telesupervision and telecontrol, automated central telecontrol, characteristics and functions of the control room, and maintenance requirements. Successful integration of the disciplines of hydraulics and electronics, computer science, and automation into a complete system design requires the following: (1) a clear definition of objectives, (2) a detailed prior study, (3) analysis of alternatives, (4) simple and flexible concept, with the possibility of evolution, (5) gathering the minimum information for global control, (6) an architecture that reduces transmissions through decentralization, (7) a study of operation in a degraded mode, (8) cost-benefit analysis, (9) careful selection of equipment and materials, (10) stepwise installation of components of the overall system, and (11) a plan for education and training of relevant personnel, beginning before system installation. (Rochester-PTT)
W89-06235

CONTROL OF WATERWORKS: STATE OF THE ART TODAY AND FUTURE DEVELOPMENTS,
PSI, Bersaustr. 4-6, D-5620 Velbert 15 (Neviges), Federal Republic of Germany.
G. Buchweitz.
Aqua AQUAAA, No. 5, p 254-260, 1988. 5 fig, 6 ref.

Descriptors: *Water treatment facilities, *Future planning, *Automation, *Control systems, *Water supply systems, *Network design, Design criteria, Management planning, Data processing, Information systems, Computers, Process control, Operating policies, Economic aspects.

Significant development trends in automation technology are discussed from the water suppliers' point of view. Increasing requirements in water supply, the widespread use of automated systems in water supply utilities, the importance of experienced personnel, increasing requirements for process supervision and control, the need for higher water quality, political and legal requirements, and future developments (ground water information systems and integrated waterworks information systems). The development in waterworks control has so far been mainly seen from a process supervision and control point of view. The last few decades have seen dramatic changes in hardware and system technology, many variants of which have been adopted by the water supply industry. Automation facilities are getting more powerful and simultaneously less expensive. Process management also is getting more efficient and more economical. Changes over the next few decades will be due mainly to environmental conditions, which are becoming more challenging. This problem and the need to keep costs for consumers low makes it necessary to think beyond process control to comprehensive information technology. An 'integrated water supply information system' requires and interdepartmental approach in water waterworks that must be supported by the organization and its staff. (Rochester-PTT)
W89-06236

FROM CARTOGRAPHIC PROGRAMS TO NETWORK INFORMATION SYSTEMS,
Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.).
For primary bibliographic entry see Field 7C.
W89-06237

INTEGRATED DISTRIBUTION MANAGEMENT SYSTEMS,
Wessex Water Authority, Bristol (England).
D. Beal, and D. E. Grimshaw.
Aqua AQUAAA, No. 5, p 267-276, 1988. 8 fig, 3 tab.

Descriptors: *Metropolitan water management, *Water distribution, *Automation, *Water supply systems, Design criteria, Management planning, Data processing, Information systems, Computers, Systems analysis, Metering, Data acquisition, Wessex Water, England, Mapping.

The integrated distribution management system developed by Wessex Water (England) is discussed, including operational management needs; data capture systems (digital mapping, telemetry, data loggers, and district and waste zone metering, including leakage monitoring); decision support systems (leakage management and pump scheduling); and systems integration. Wessex Water supplies water directly to 50% of the 2.4 million people living in the region (SW England) for an average of 400,000 cu m/day. 'New' technology is being applied in an effort to meet the apparently conflicting objectives of maintaining standards of customer service while reducing operating costs. The Wessex Water network includes mainframe, mini, and microcomputers made by various vendors; major centers are connected by a dedicated megastream ring for the transmission of voice and computer data. Despite an integrated hardware strategy, it always has been difficult to access data from the appropriate information system on a single workstation. Wessex Water is currently developing a practical means of meeting this objective through its Water Management System. The goal is to make any workstation a gateway into a range of information sources and decision support systems together with facilities for merging data and management report generation. (Rochester-PTT)
W89-06238

COMMUNITY WATER SUPPLY IN THE USSR,
A. F. Porjadin, and G. A. Orlov.
Aqua AQUAAA, No. 5, p 277-280, 1988.

Descriptors: *Community development, *Soviet Union, *Water supply, *Water use, Water treatment facilities, Water quality control, Standards, Drinking water.

Sources of supply, water use, capacities of waterworks, drinking water quality and treatment, and future developments in the water supply of the Soviet Union are discussed. Although ground water supplies most of the cities and towns in the country, it does not supply most of the volume because the large cities use surface water sources. Renewable fresh water sources amount to 4700 billion cu m/yr. Average per capita water use in urban areas of the USSR is 446 liters, of which 71% is used in residential areas, including a domestic use of 46%, public use of 25%, and about 29% for industrial, transport, and other activities. The total capacity of urban waterworks in the country is 105 million cu m/day; waterworks with capacities of more than >100,000 cu m/day account for 75% of this total capacity but only 10.6% of the number of water plants. The State Drinking Water Standards (GOST 2874-82) lists over 1000 chemicals for which a maximum allowable concentration has been set; coliform content is limited to 3/L under this standard. Various treatment processes are used, depending on the condition of raw water most in need of correction. (Rochester-PTT)
W89-06239

KINETICS AND MECHANISMS OF HYPOCHLORITE OXIDATION OF CREATININE (CINETIQUES ET MECANISMES DE LA DEGRADATION DE LA CREATININE SOUS L'ACTION DE L'HYPOCHLORITE),
Ecole Nationale de la Sante Publique, Rennes (France). Lab. d'Etude et de Recherche en Environment et Sante.
Z. Alouini, and R. Seux.
Water Research WATRAG, Vol. 22, No. 12, p 1519-1526, December 1988. 6 fig, 1 tab, 6 ref. English summary.

Descriptors: *Water treatment, *Wastewater treatment, *Creatinines, *Chlorination, *Path of pollutants, *Oxidation, Chemical reactions, Chlorine, Hypochlorites, Hydrogen ion concentration, Chemical analysis, Kinetics.

An area of substantial interest in current research on chlorination is the formation, stability and nature of chloramines formed by the interaction of chlorine with nitrogen organic compounds of biological origin in natural waters. The kinetics and mechanisms of formation and decomposition of N-chlorocreatinines are examined for a range of hypochlorite creatinine ratios and pHs. The following of creatinine and chloramines concentrations by the diethyl paraphenylene diamine-fast titrimetric method and by their spectra confirmed earlier works. However, we observed dichloramine formation when the molar ratio of hypochlorite and creatinine was sufficient to decompose all chlorinated creatinine forms. The creatinine determination (HPLC method) suggested that N-chlorocreatinines were formed rapidly at an initial stage. Then they were decomposed by an apparent first order reaction at pH 8. The reaction in the initial stage should be considered as an electrophile substitute followed slowly by hydrolysis when the pH remained around 8. If the addition of hypochlorite affects the amine group of the molecule, 1-methylhydantoin is produced with chloramine. Reaction yield was about 10 % of the initial creatinine. In acid aqueous solution, with a molar ratio of 3, we also obtained trichlorocreatinine. It appears that N-chlorocreatinines formed during the chlorination of natural or swimming pool water were relatively stable, leading to the increase of the combined chlorine level. This stability was a function of the molar ratio of hypochlorite and creatinine, and pH. However, since most of the different types of water had a pH in the range of 6-9, there would be little effect of pH at ambient temperature. (Author's abstract)
W89-06299

NON-BIOLOGICAL EVOLUTION, IN WATER, OF SOME THREE- AND FOUR-CARBON ATOM ORGANOHALOGENATED COMPOUNDS: HYDROLYSIS AND PHOTOLYSIS (EVOLUTION NON BIOLOGIQUE DANS L'EAU DE COMPOSES ORGANOHALOGENES A TROIS ET QUATRE ATOMES DE CARBONE: HYDROLYSE ET PHOTOLYSE),
Universite de Toulon et du Var, La Garde (France). Lab. de Chimie Appliquee.
J. C. Milano, A. Guibourg, and J. L. Vernet.
Water Research WATRAG, Vol. 22, No. 12, p 1553-1562, December 1988. 7 tab, 34 ref. English summary.

Descriptors: *Chlorination, *Water treatment, *Halogenated aliphatic hydrocarbons, *Hydrolysis, *Photolysis, Chlorinated hydrocarbons, Chemical reactions, Hydrogen peroxide, Acetone.

Chemical decomposition, in situ and during water treatment, of some average molecular weight aliphatic compounds were studied. These compounds are widely used and many are formed during water treatment by chlorine or its by-products. Most of these compounds are toxic and have been found in natural waters, especially drinking water, and they are very resistant to biological degradation. Therefore, their evolution in water via the two principal processes of chemical degradation in the environment -- hydrolysis and photolysis were studied. Degradation velocity by hydrolysis and the nature of the compounds formed were determined for each of the seventeen products studied. The degra-

dation products were halogenated alcohols. The photochemical degradations were done with a medium-pressure mercury vapor u.v. lamp in quartz and pyrex tubes. The degradation velocity and the structure of the photoproducts are specified. The influence of acetone and hydrogen peroxide on photochemical degradation was also studied. Hydrogen peroxide considerably increased photodegradation velocities. Reaction-mechanism hypotheses are proposed for pure demineralized water and in the presence of hydrogen peroxide and acetone. The degradation begins by a homolytic rupture of the most labile halogen-carbon bond to yield the most stable halogenated hydrocarbon radical, by reaction with molecular oxygen present in the medium and by reaction with water. These mechanisms explain the formation, during the reaction, of halogenated alcohols, ketones, alkenes and epoxides, and also of allylic alcohol, acetone and methanol. (Author's abstract)
W89-06303

DOSE-RESPONSE OF ESCHERICHIA COLI IN OZONE DEMAND-FREE PHOSPHATE BUFFER,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5D.
W89-06304

GENOTOXIC ACTIVITY OF ORGANIC CHEMICALS IN DRINKING WATER,
Health Effects Research Lab., Cincinnati, OH. Toxicology and Microbiology Div.
For primary bibliographic entry see Field 5C.
W89-06366

FREON FC-113, AN ALTERNATIVE TO METHYLENE CHLORIDE FOR LIQUID-LIQUID EXTRACTION OF TRACE ORGANICS FROM CHLORINATED DRINKING WATER,
Drexel Univ., Philadelphia, PA. Dept. of Chemistry.
For primary bibliographic entry see Field 5A.
W89-06367

ANTIBIOTIC RESISTANT COLIFORM AND FAECAL COLIFORM BACTERIA IN DRINKING WATER,
Biological Research Center, Baghdad (Iraq). Dept. of Environmental Pollution.
S. F. Jazrawi, Z. A. Al-Doori, and T. A. Haddad.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 377-382, June 1988. 2 tab, 15 ref.

Descriptors: *Water sampling, *Drinking water, *Bacteria, *Coliforms, *Antibiotics, *Feces, Antibiotic resistant bacteria, Bacterial analysis, Iraq.

Coliform and fecal coliform were isolated from drinking water samples obtained from tap water (TW) and storage tanks (ST) in Baghdad city. All isolates were identified and tested for their resistance to 12 antibiotics. Bacterial identification revealed that Enterobacter cloacae and Klebsiella pneumoniae were the predominant organisms from TW and ST water samples, respectively. Overall, 66% of the isolates from TW and 38% from ST were resistant to one or more of the drugs tested. Ampicillin, Carbenicillin, Cefalotin and Colistin resistance in particular were more frequent among bacterial isolates. The overall frequency of multiple antibiotic resistance among bacterial isolates in TW and ST samples were 47% and 33%, respectively. All bacterial strains isolated from drinking water were sensitive to Rifampicin. The results demonstrate the need for periodic bacteriological examination of drinking water and restriction in the use of antibiotics in Iraq. (Author's abstract)
W89-06394

MYTHOS OF THE SATURATION INDEX AND INSTATIONARY CORROSION,
Karlsruhe Univ. (Germany, F.R.).
H. Sontheimer.
Zeitschrift fuer Wasser - und Abevasser Forschung ZWABAQ, Vol. 21, No. 6, p 219-227, December 1988. 1 tab, 17 fig, 25 ref. English summary.

Descriptors: *Water conveyance, *Drinking water, *Corrosion, *Corrosion control, *Saturation index, Sulfates, Rust, Bicarbonate, Phosphates.

It has been generally accepted that drinking water for reasons of corrosion protection should have a saturation index of about 0. Recent studies have shown that not the corrosion itself, but the formation of rusty water has always been the most important problem. It occurs mainly with standing water and is a consequence of the so called instationary corrosion. An explanation of this type of corrosion is proposed. The water constituents, especially bicarbonate and sulfate have a special importance because they influence the redox-cycle. Here sulfate reduces the positive effect of bicarbonate to form non reactive Goethite (FeO(OH)). Salt concentration and buffer intensity are of direct influence to the formation of rusty water, while phosphate has a positive influence. CaCO3 and its formation as well as its dissolution velocity does not influence the formation of rusty water. (Author's abstract)
W89-06415

TWO-STAGE OZONATION BEING USED IN SHREVEPORT, LA, FOR ORGANICS CONTROL,
Shreveport Dept. of Water and Sewerage, LA.
R. J. Tuttle, and J. C. Hesby.
Southwest and Texas Water Works Journal STVJDV, Vol. 70, No. 10, p 4-8, January 1989. 7 fig, 6 tab.

Descriptors: *Water treatment facilities, *Trihalomethanes, *Ozonation, *Disinfection, *Chlorine dioxide, *Water treatment, Chloramines, Chlorination, Louisiana, Organic wastes, Ozone.

In an effort to improve its water treatment processes and reduce levels of total trihalomethanes in treated water, the city of Shreveport, Louisiana adopted ozonation in its two water treatment facilities. Each treatment plant is being provided with a complete ozone generation-dissolution-destruct system. System pressure is provided by liquid ring type air compressors. Ozone gas is applied to the water in counter-current covered concrete contact basins through ceramic rod fine bubble diffusers. The basins are covered with off-gas collection vent blowers. Each ozone system is provided with an independent programmable logic controller resident in the ozone instrument panel. Control of applied dose to the pre-contact and post-contact basins at each plant is accomplished through manual division of air flow. The unit costs, based on generating capacity, indicate a significant economy of scale. Initial plant performance at the McNeil water treatment plant shows reductions in color, turbidity, and total trihalomethane levels in finished water. This data indicates that by using ozone as the primary oxidant and chloramines for disinfectant residual, the city will be able to comply with the anticipated further tightening of trihalomethane regulations. (Geiger-PTT)
W89-06477

DESALINATION COSTS IN AUSTRALIA; A SURVEY OF OPERATING PLANTS,
Commonwealth Scientific and Industrial Research Organization, Clayton (Australia). Ian Wark Labs.
For primary bibliographic entry see Field 3A.
W89-06495

DESALINATION OF NON-CHLORINATED SURFACE SEAWATER USING TFC MEMBRANE ELEMENTS,
Allied-Signal, Inc., San Diego, CA. UOP Fluid Systems.
For primary bibliographic entry see Field 3A.
W89-06496

NANOFILTRATION MEMBRANES BROADEN THE USE OF MEMBRANE SEPARATION TECHNOLOGY,
FilmTec Corp., Minneapolis, MN.
For primary bibliographic entry see Field 3A.
W89-06497

DETAILED INVESTIGATION OF EFFECTS OF OPERATING PARAMETERS OF ULTRAFILTRATION USING LABORATORY-SCALE ULTRAFILTRATION UNIT,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5D.
W89-06501

CHANGES IN COAGULANT DEMAND WITH PRE-OZONATION OF COLOURED WATER,
Imperial Coll. of Science and Technology, London (England).
N. J. D. Graham, and C. Kotsani.
Proceedings of the Institution of Civil Engineers PCIEAT, Vol. 85, p 713-719, December 1988. 5 fig, 2 tab, 11 ref.

Descriptors: *Ozonation, *Coagulation, *Water treatment, *Humic acids, Color, Aluminum sulfate, Chemical reactions.

The process of coagulant-assisted direct filtration is common for treating upland colored surface waters in Scotland and northern England. The addition of a chemical coagulant is essential to precipitate soluble humic substances. A laboratory study using a batch quantity of extracted humic material was undertaken to discover whether pre-ozonation of colored water could reduce the coagulant (aluminum sulfate) demand of the water. Ozone was found to reduce both the color and UV-visible light-absorbing properties of the humic material before the addition of coagulant. With the addition of coagulant, ozonation appeared to have two effects: an increasingly higher coagulant dose was required to initiate coagulation; beyond the dose threshold for coagulation, the colored humic material is less readily coagulated with increasing ozone exposure. Overall, ozonation appears to increase the coagulant demand of the humic material. There is evidence that an increasing exposure of humic material to ozone causes an increasing degree of change in the physicochemical nature of the humic material; such changes appear to be detrimental to the efficiency of aluminum humate precipitation. (Doria-PTT)
W89-06547

WATER QUALITY DETERIORATION: RECOGNIZING THE SYMPTOMS,
Missouri Univ.-Columbia. Dept. of Civil Engineering.
J. T. O'Connor, S. K. Banerji, and B. J. Brazos.
Public Works PUWOAH, Vol. 119, No. 13, p 44-46, December 1988. 1 fig, 3 ref.

Descriptors: *Impaired water quality, *Water quality control, *Water distribution, *Water treatment, *Drinking water, Corrosion control, Pipes, Bacteria, Nitrification, Residual chlorine, Iron, Organoleptic properties.

Substantial degradation of water quality often occurs during distribution to the consumer, causing such common nuisances as iron staining, unpleasant tastes and odors, and the presence of sediment. Before remedial actions can be taken, the water supply system must be thoroughly examined to determine the possible role of bacteria in creating or aggravating these conditions. Bacteria may promote accumulations on pipe walls, create tastes and odors, and produce nitrification and the loss of oxygen, sulfate reduction, and methane formation. In terms of corrosion of distribution system components and pipe, as well as household plumbing, bacteria-laden accumulations on pipe surfaces may range from somewhat beneficial to very harmful. Distribution systems should be monitored for iron, chlorine residual, oxygen depletion, and the presence of volatile solids in sediments dislodged from mains during flushing. Deterioration may be controlled by the physical removal of influent microbial cells and the removal of nutrients. The goal should be to make treated water incapable of supporting bacterial growth before it is discharged into the distribution system; an alternative is a program of regular main cleaning and flushing. (Doria-PTT)
W89-06553

WORKSHOP DESIGN FOR WELL IMPROVEMENT: PROTECTING OPEN WELLS,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 4B.
W89-06604

OXIDATION OF FORMALDEHYDE SOLUTIONS USED FOR THE PRESERVATION OF REVERSE OSMOSIS MEMBRANES: PHASE II,
Water and Power Resources Service, Denver, CO. Engineering and Research Center.
W. J. Boegli, C. D. Moody, A. P. Murphy, and L. H. Rowley.
Available from National Technical Information Service, Springfield, VA 22161, as PB89-109946. Price codes: A05 in paper copy; A01 in microfiche. Report No. REC-ERC-87-13, December 1987. 94p, 31 fig, 9 tab, 16 ref, 5 append.

Descriptors: *Preservation, *Water treatment, *Reverse osmosis, *Membrane processes, *Formaldehyde, *Oxidation, Chemical treatment, Formic acid, Ion exchange, Desalination, Catalysts, Membranes, Prototypes, Pilot plants, Carbon dioxide, Chemical reactions.

This report presents the results of the second phase of a two-phase study of a new process for the catalytic oxidation, at ambient temperatures, of dilute formaldehyde used in aqueous solutions for the preservation of cellulose acetate reverse osmosis membranes. The oxidation, involving hydrogen peroxide and an iron (ferric chloride) catalyst, was previously tested in a bench-scale adiabatic reactor to develop test data showing the effect of selected variables (temperature, reactant and catalyst concentrations, and stirring rate) on the oxidation of formaldehyde and formic acid, an intermediate oxidation product. The reaction was shown to be effective in oxidizing formaldehyde solutions, having initial concentrations of between 250 and 950 mg/L, to carbon dioxide and water. Following oxidation, residual formaldehyde levels measured < 2 mg/L (detection limit of the analytical method used) in the aqueous phase and < 0.4 mg/cu m in the carbon dioxide vapor phase. The oxidation was found to be rate controlled rather than mass diffusion controlled. Additional adiabatic tests were conducted at a pilot-scale (solution volume 426 times greater than bench-scale) to verify the assumption of direct scale-up for the reactor. In addition, the effects of background salinity, mixing power input, and method of hydrogen peroxide addition to the reactor (metered versus batch addition) were investigated. An empirical reaction-rate model was developed from a series of isothermal bench-scale tests to predict and optimize the reaction. Parameter estimates and standard errors are presented for the oxidation of methanol (a preservative in the formaldehyde stock solution), formaldehyde, and formic acid, and for the decomposition of hydrogen peroxide. Conclusions are drawn relative to both the optimum pH range for the oxidation and the inhibiting/promoting effects of selected components in the reaction. (Author's abstract)
W89-06627

ESTABLISHING A LEVEL OF CONFIDENCE FOR THE ANALYTICAL VALUES FOR THE TRACE METALS IN THE LOS ALAMOS DRINKING WATER SUPPLY AND DISTRIBUTION SYSTEM,
For primary bibliographic entry see Field 5A.
W89-06648

EFFECTS OF HUMIC SUBSTANCES ON METAL SPECIATION,
Georgia Inst. of Tech., Atlanta. School of Geophysical Sciences.
E. M. Perdue.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-133632. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/251, December 1987. 29p, 3 fig, 2 tab, 26 ref. EPA Contract CR8133471-01.

Descriptors: *Humic substances, *Chemical speciation, *Water treatment, *Organic matter, *Model studies, *Metals, Thermodynamics, Chemical properties, Chemical reactions, Hydrogen ion concentration, Metal complexes.

The use of thermodynamic models to calculate the effect of humic substances on metal speciation on waters treatment processes requires that the complexation capacity (CC) of the humic substance be determined. If the CC of a humic substance, like that of a single ligand, is viewed as a compositional rather than thermodynamic property, then the conventional approaches toward experimental measurements and calculations of complexation capacities need to be re-examined. This paper addresses some of the problems that must be understood and solved before the effects of metal-humic complexation processes can be quantitatively addressed. The heterogeneity of ligands in a humic substance not only complicates the mathematical description of equilibrium data but also makes the complexation capacity of a humic substance almost impossible to accurately determine. Complexation capacities (meq/g) of humic substances are widely reported to vary with pH, ionic strength, concentration of the humic substance used in the measurement, and with the nature of the metal being studied and that for metal complexation reactions. (Lantz-PTT)
W89-06668

DETERMINATION OF A CHLORINATED FURANONE (MX) IN TREATED WATER,
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W89-06669

GUIDELINES FOR INSTITUTIONAL ASSESSMENT: WATER AND WASTEWATER INSTITUTIONS,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 6E.
W89-06678

ASSESSMENT OF RISKS ASSOCIATED WITH ENTERIC VIRUSES IN CONTAMINATED DRINKING WATER,
Arizona Univ., Tucson. Dept. of Microbiology and Immunology.
For primary bibliographic entry see Field 5A.
W89-06747

ORGANIC MICROPOLLUTANTS IN THE AQUATIC ENVIRONMENT: PROCEEDINGS OF THE FIFTH EUROPEAN SYMPOSIUM, HELD IN ROME, ITALY, OCTOBER 20-22, 1987.
For primary bibliographic entry see Field 5A.
W89-06748

MUTAGENIC COMPOUNDS IN CHLORINATED WATERS,
Abo Akademi, Turku (Finland). Lab. of Forest Products Chemistry.
For primary bibliographic entry see Field 5D.
W89-06784

FORMATION AND REMOVAL OF CHEMICAL MUTAGENS DURING DRINKING WATER TREATMENT,
Water Research Centre, Medmenham (England). Medmenham Lab.
M. Fielding, and H. Horth.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 284-298. 3 fig, 4 tab, 42 ref.

Descriptors: *Mutagenicity, *Water treatment, *Chlorination, *Drinking water, Humic acids, Disinfectants, Toxicity, Chemical properties, Biochemistry, Bioassays, Activated carbon.

The application of bacterial mutagenicity tests to drinking water has shown the presence of mutagens. Invariably, mutagens generated during water treatment chlorination account for much of the mutagenicity detected in most surface-water-derived drinking waters. These mutagens are formed from widespread, naturally occurring precursors, such as humic substances, although other substances, especially amino acids, may be involved. Most of the chlorination-derived mutagens identified account for little of the mutagenicity of drinking water. One mutagen, 3-chloro-4-(dichloromethyl)-5-Hydroxy-2(5H)-furanone (MX) is highly potent and may have a significant contribution. Its occurrence and toxicity need full evaluation. Other oxidants/disinfectants, such as ozone and chlorine dioxide, can also generate mutagens but these are likely to differ from those produced by chlorination. Granular activated carbon is effective in removing chlorination-derived mutagens but less effective for precursors. Dechlorinating agents, such as sulfur dioxide, can eliminate some of the mutagens produced by chlorination. The bacterial mutagenicity test cannot give information on the actual risks to health posed by the mutagens. Such information could arise from follow-up work on identified major mutagens and from application of other bioassays more indicative of effects in man. Consequently, it is difficult to justify major changes in treatment practice aimed solely at controlling mutagenicity. (See also W89-06748) (Author's abstract)
W89-06785

APPLICATION OF THE OZONE-HYDROGEN PEROXIDE COMBINATION FOR THE REMOVAL OF TOXIC COMPOUNDS FROM A GROUNDWATER,
Centre de Recherche Lyonnaise des Eaux - Degremont, Le Pecq (France).
J. P. Duguet, C. Anselme, P. Mazounie, and J. Mallevialle.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 299-309. 4 fig, 5 tab, 12 ref.

Descriptors: *Dye industry wastes, *Toxicity, *Water treatment, *Groundwater pollution, *Benzene, *Water pollution, *Drinking water, Feasibility studies, Chlorination, Monitoring, Test wells, Industrial wastes, Water pollution effects.

Nitro and chloro-benzenic compounds, which are widely used in dye industries, have been associated recently with groundwater contamination. Because of their potential toxicity and for taste and odor considerations, three main actions were decided upon to solve the problem. First, to follow the advance of pollution toward the wells, samples were collected automatically and analyzed using GC-MS. Results indicated that o-chloronitrobenzene was the main pollutant in concentrations ranging from 10 to 20,000 micrograms/L. Second, to monitor the drinking water quality, an on-line spectrophotometer was used to measure the optical density at 254 nm at the inlet and outlet of the plant. Third, the feasibility of using the O3/H2O2 combination was determined at a 450 L/h pilot plant. Reduction of chloronitrobenzenes from 1.9 mg/L to less than 20 micrograms/L could be reached by the application of 8 g O3/cu m and 3 g H2O2/cu m with a 20-minute contact time. To avoid an eventual bacterial regrowth in the network due to biodegradability of the oxidation by-products, sand and GAC filtration were tested after oxidation. An evaluation of the costs of these different treatments is presented. In the case of a large decrease of the pollution to be treated, hydrogen peroxide injection can be suppressed, resulting in a classical treatment and a minimization of operating costs. (See also W89-06748) (Author's abstract)
W89-06786

POSSIBILITIES AND LIMITATIONS OF THE COMBINED USE OF OZONE AND HYDROGEN PEROXIDE IN DRINKING WATER PREPARATION FROM SURFACE WATER,
Antwerpse Waterwerken (Belgium).
F. Van Hoof, J. Janssens, and E. Pluys.

IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 312-317. 4 fig, 6 ref.

Descriptors: *Ozonation, *Feasibility studies, *Water treatment, *Drinking water, Adsorption, Oxidation, Activated carbon, Ozone, Surface water.

The feasibility of the combined use of ozone and hydrogen peroxide in surface water preozonation and in the ozonation of pretreated water was evaluated in relation to H2O2 dosage, time of H2O2 addition, O3 dosage TOC, UV254 absorption, formation of oxidation by-products, trihalomethane precursor removal and adsorption on activated carbon in comparison with the use of ozone as such. Although in all cases a small but consistently better UV 254 removal was observed through the combined use of ozone and hydrogen peroxide, the beneficial effects for other parameters were limited or non-existent, especially within the range of ozone doses applied during surface water preozonation (< 2 mg/L). Therefore, the combined application of ozone and hydrogen peroxide seems to have little advantage over the use of ozone alone in the treatment of this type of surface waters. (See also W89-06748) (Author's abstract)
W89-06787

MASS SPECTROMETRIC IDENTIFICATION OF HALOGENATED SURFACTANTS IN BARCELONA'S WATER TREATMENT PLANT,
Instituto de Quimica Bio-Organica, Barcelona (Spain). Lab. d'Espectrometria de Masses.
J. Rivera, F. Ventura, J. Caixach, D. Fraisse, and I. Espadaler.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 329-337. 7 fig, 1 tab, 26 ref.

Descriptors: *Water pollution sources, *Spectrometers, *Halogens, *Surfactants, *Water treatment, *Phenols, *Pollutant identification, Chemical properties, Chlorination, Textile mill wastes, Dyes, Industrial wastes, Dye industry wastes.

Polyethoxylated C12-15 alcohols nonylphenols and ((nonylphenoxy) polyethoxy) acetic acid and their brominated derivatives were identified in the River Llobregat (Spain) and in the tap water of Barcelona, Spain, by GC/MS and FAB mass spectrometry. The formation of halogenated derivatives of alkylphenols and acidic alkylphenols in the chlorination process are reported, with the most common being monobrominated compounds, which is in agreement with majority formation of bromoform and other brominated trihalomethanes during normal operating conditions of the local water works plant. Whereas GC/MS is limited to those compounds with a low polyethoxylation degree, FAB mass spectrometry is a fast and simple technique to determine surfactants with a high range of oligomers present in the samples. It is suggested that both techniques are complementary. The source of these compounds are the dumps of surfactant industries and dyeing and textile processes. Their brominated derivatives are formed in the chlorination stages in the water works plant due to a high content of bromide ions in the upper course of the river. (See also W89-06748) (Friedmann-PTT)
W89-06790

EFFECTS OF CHLORINE DIOXIDE PREOXIDATION ON ORGANIC HALIDE FORMATION POTENTIALS, (IN FRENCH),
Poitiers Univ. (France). Lab. de Chimie de l'Eau et des Nuisances.
H. B. Amor, J. De Laat, and M. Dore.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 338-343. 1 fig, 3 tab, 13 ref.

Descriptors: *Halides, *Water treatment, *Trihalomethanes, *Chlorination, Chemical properties, Oxidation, Surface water, Raw water, Humic acids, Natural waters, Organic compounds.

The effects of a preoxidation with chlorine dioxide on the production of organohalogenated compounds (trihalomethanes, dichloroacetic and trichloroacetic acids), formed from the chlorination of different raw surface waters and of isolated aquatic humic substances, was determined. Samples of natural waters and of fulvic and humic acid solutions were oxidized for a reaction time of 24 hr with increasing doses of chlorine dioxide (from 0 to 2.5 mg of ClO2 per mg of TOC), then heavily chlorinated (chlorine doses: 40-60 mg/L, reaction time: 72 hrs). The results obtained with laboratory experiments showed that there was a significant decrease in the formation potentials of trihalomethanes (45-55%), of dichloroacetic acid (30-40%) and of trichloroacetic acid (40-60%) as well as in the chlorine demand during postchlorination (10-20%). Compared to chlorine, chlorine dioxide produced very small amounts of organohalogenated compounds. (See also W89-06748) (Author's abstract)
W89-06791

INFLUENCE OF HUMIC WATER SUBSTANCES ON THE DEGRADATION OF PAH DURING WATER CHLORINATION,
National Inst. of Public Health, Oslo (Norway).
G. Becher, and S. Johnsen.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 353-356. 1 fig, 1 tab, 5 ref.

Descriptors: *Humic acids, *Water treatment, *Chlorination, *Chemical degradation, Chemical reactions, Hydrogen ion concentration, Lakes, Artificial water, Sampling, Chemical propertied, Bogs.

C-14-labelled benzo(a)pyrene (BaP) was added to samples of three types of water: bog, lake, and artificial water. After equilibration, the samples were chlorinated with NaOCl solution under buffered conditions. After 72 h, BaP and degradation products were extracted consecutively with CH2Cl2 at neutral pH, then at acidic pH, and finally by absorption to XAD-2. The extracts were subjected to fractionation by reverse-phase HPLC. In contrast to the artificial water, about 20% of the reaction products could not be extracted from the humic water samples. This might be due either to the formation of more water soluble degradation products in the presence of humic matter, or strong complexation of these products to humus. No significant difference in the reaction product profile was observed in the neutral CH2Cl2 extract of either of the three water samples; i.e., humus has no effect on the distribution of reaction products in this fraction. (See also W89-06748) (Author's abstract)
W89-06794

HEALTH ASPECTS OF REUSE OF TREATED WASTEWATER FOR IRRIGATION,
World Health Organization, Alexandria (Egypt). Regional Office for the Eastern Mediterranean.
P. J. Hillman.
IN: Treatment and Use of Sewage Effluent for Irrigation, Butterworths, London. 1988. p 52-63, 4 tab, 15 ref.

Descriptors: *Wastewater irrigation, *Wastewater disposal, *Water reuse, *Land disposal, *Irrigation effects, *Irrigation practices, *Public health, Fate of pollutants, Path of pollutants, Wastewater treatment, Standards, Toxicity, Pathogens, Pathogenic bacteria, Bacteria, Protozoa, United Nations, Hazards, Domestic wastes, Primary wastewater treatment, Parasites, Stabilization ponds, Monitoring.

The use of wastewater for irrigation poses a health hazard directly to the field hands and in some instances people living close to the irrigated area, and indirectly to the general public. Domestic sewage is generally a substantial component of wastewater and contains all the micro-organisms and parasites commonly found in excreta. Wastewater may also contain chemical substances potentially hazardous to health. A 1973 report recommended that any wastewater used for agriculture should have a minimum of primary treatment for uses on crops not intended for human consumption. Later studies recommend the almost complete removal of the eggs of intestinal nematodes and a major reduction in excreted bacteria. Waste stabilization ponds are recommended for wastewater treatment; however, the extensive land requirements of ponds may limit their use. Controls should include a surveillance program of the quality of raw wastewater and of the wastewater effluent used for irrigation, crops should be monitored, and it may be necessary to include groundwater surveillance. (See also W89-06801) (White-Reimer-PTT)
W89-06805

APPLICATION OF ZONAL PRICING TO A METROPOLITAN WATER UTILITY,
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
For primary bibliographic entry see Field 6C.
W89-06917

HEURISTIC APPROACH TO THE ANALYSIS OF A CONJUNCTIVE WATER SUPPLY SYSTEM,
Oklahoma Univ., Norman. Dept. of Civil Engineering and Environmental Science.
A. J. Gonzalez.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8625533. Ph.D. Dissertation, 1986. 119p, 14 fig, 15 tab, 39 ref, 7 append.

Descriptors: *Conjunctive use, *Water supply development, *Management planning, *Multiobjective planning, Reservoir operation, Aquifer management, Interbasin transfer, Optimum development plans, Optimization, Reservoir yield, Reservoir yield, Model studies, Computer programs.

A methodology was developed for analyzing the conjunctive use of a reservoir, an interbasin transfer, and an aquifer. The methodology heuristically seeks the optimum use of resources given a set of objectives and provides a means for generating non-inferior solutions. The incorporation of both uncertain decisions and increasing demand into the analysis requires a major increase in complexity; consequently, a large number of possible solutions were generated. Comparison between the results of fixed reservoir yield analysis with variable yield revealed that the latter approach permitted a significant improvement in terms of spills, imports, aquifer contribution, and risk. A major disadvantage of this technique is its inability to provide an optimal management strategy directly. It requires, as any other simulation model, a large number of trails to achieve acceptable results. Results of a case study provided information for the managers and users of the Norman Project in Central Oklahoma. Specific combinations of conjunctive use policies that were not studied can be investigated using computer programs developed during this research. (Cremmins-AEPCO)
W89-06930

FINANCIAL STABILITY OF PUBLICLY OWNED WATER SYSTEMS IN SOUTH CAROLINA,
Clemson Univ., SC. Graduate School
For primary bibliographic entry see Field 6C.
W89-06934

ICE AND SEDIMENT FACTORS IN THE SELECTION OF INUIT WATER SUPPLIES FROM LENTIC SOURCES,
Wisconsin Univ.-Milwaukee. Dept. of Geography.
M. H. Hermanson.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8607544. Ph.D. Dissertation, 1985. 206p, 29 fig, 40 tab, 107 ref, append.

Descriptors: *Arctic zone, *Water supply, *Lakes, *Ice, *Sedimentation, *Lentic environment, Public

policy, Water policy, Arctic, Ice cover, Water resources development, Freezing, Chemical properties, Physical properties, Northwest Territories.

Criteria were developed for water supply selection in the Arctic from lentic sources that meet the standards of the community and governmental authorities. The evolution of water supply systems and development policies in the Government of the Northwest Territories was evaluated and major natural processes in ice-covered lakes that may affect the viability of water supply were identified through review of the literature. A case study is presented of the effects of these processes on lakes that are suitable for use as water supplies near a particular arctic community. The effects of freeze concentration are quantified. Determination of the best source of water in Inuit communities requires identification of a lake in which the effects of ice and sediment are minimized. Prediction of ice impacts is easily accomplished by using physical and chemical data from a lake. Potential sediment effects can be indicated by the oxygen regime under ice cover. (Cremmins-AEPCO)
W89-06935

INSTITUTIONAL AND ECONOMIC ANALYSIS OF RURAL WATER SUPPLY INFRASTRUCTURE DETERIORATION IN NEW YORK STATE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6A.
W89-06936

EFFECT OF PRESSURE FLUCTUATIONS ON PIPE FAILURE IN WATER DISTRIBUTION SYSTEMS,
Akron Univ., OH. Graduate School.
For primary bibliographic entry see Field 8B.
W89-06938

DISINFECTION BY ULTRAVIOLET RADIATION FOR DRINKING WATER CONTAINING GIARDIA SP. AND HUMUS,
Washington Univ., Seattle. Dept. of Civil Engineering.
T. S. Wang.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8706697. Ph.D. Dissertation, 1986. 236p, 89 fig, 22 tab, 70 ref, 7 append.

Descriptors: *Giardia, *Ultraviolet radiation, *Disinfection, *Drinking water, *Bacteria, *Water treatment, Potable water, Decomposing organic matter, Survival, Pathogenic bacteria.

Drinking water containing Giardia cysts and humus was disinfected using ultraviolet radiation. More than 99% of the cysts failed to survive at least two days under a relative humidity of less than 20%. Survival of the cysts in river water was a factor of physiological inactivation and physical disintegration. Within the temperature range of 1 C to 30 C, the total survival time of cysts in natural water decreased as the water temperature increased. The activation energy of Giardia cysts indicated that their resistance to disinfection would be higher than that for E. coli and M. fortuitum. The zero point of charge was about pH 3.3 for Giardia cysts and the surface charge decreased with aging. The surface charge was also independent of the viability of the cysts and dependent on the degree of integrity of the cyst membrane. Within pH 6 to 8, the cyst settling velocity increased as the pH of the water in the settling column decreased. Poisson distribution tests at pH 6 and 7 indicated a clustered or contagious distribution for the Giardia cysts in water. At a pH of 8, the distribution was random. Ferrioxalate actinometry was sensitive for high UV intensities and disinfection doses. Humus concentrations were significantly reduced after UV irradiation. (Cremmins-AEPCO)
W89-06943

DEVELOPMENT AND EXPERIMENTAL VERIFICATION OF A STRUCTURED MICROBIAL GROWTH MODEL AND AN EMPIRICAL MICROBIAL HYDROLYSIS MODEL FOR AN AEROBIC BIOLOGICAL REACTOR WITH LIGNOCELLULOSIC SUBSTRATE,
Cornell Univ., Ithaca, NY. Graduate School of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-06954

5G. Water Quality Control

EFFECT OF ACID RAIN LEGISLATION ON THE ECONOMICS OF CO2 RECOVERY FROM POWER PLANTS,
Bowling Green State Univ., OH. Dept. of Physics.
T. B. Cobb, D. G. Streets, T. D. Veselka, and A. M. Wolsky.
Environmental Progress ENVPDI, Vol. 7, No. 4, p 247-256, November 1988. 4 fig, 5 tab, 24 ref. DOE Contract W-31-109-Eng-38.

Descriptors: *Water pollution prevention, *Air pollution control, *Powerplants, *Acid rain, *Legislation, *Cost-benefit analysis, *Carbon dioxide, *Waste recovery, Legal aspects, Economic aspects, Recycling, Air pollution, Sulfur compounds, Cost analysis, Costs, Technology, Rainfall.

Pending acid rain legislation poses serious economic and technical challenges for some utilities. Two contrasting examples of proposed legislation were analyzed to quantify the incentives that the enactment of such legislation might create for utilities to seek alternate means to mitigate the imposition of specific control technologies. The cost of conventional control strategies was determined for every major coal-fired power plant in the 31-state region targeted by the legislation, and cost savings achieved through the avoidance of technology retrofits were calculated. Acid rain credits, equal to the avoided cost/unit of CO2 produced, were tabulated and used to characterize those plants most likely to have the highest incentive to participate in such activities. It is concluded that coal-fired plants could provide added potential for certain oil recovery operations where natural sources of CO2 are not readily available. More than 100 power plants in 20 states were identified with high incentives for avoiding conventional emission control technologies. Of these plants, 24 are located within 100 miles of pipelines available for immediate CO2 service. (Doria-PTT)
W89-05809

IN-SITU EXTRACTION OF INDUSTRIAL SLUDGES,
Rutgers - The State Univ., Piscataway, NJ. Dept. of Chemical and Biochemical Engineering.
For primary bibliographic entry see Field 5E.
W89-05811

EXTRACTION AND SOLID PHASE CLEANUP METHOD FOR PESTICIDES IN SEDIMENT AND FISH,
Florida Univ., Gainesville. Dept. of Environmental Engineering Sciences.
For primary bibliographic entry see Field 5A.
W89-05815

SHRINKAGE BEHAVIOR OF CLAY LINER MATERIAL EXPOSED TO SIMULATED MUNICIPAL SOLID WASTE LANDFILL LEACHATE,
Alberta Univ., Edmonton. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-05822

ROLE OF INTERCEPTOR DITCHES IN LIMITING THE SPREAD OF CONTAMINANTS IN GROUND WATER,
Wisconsin Univ.-Madison. Dept. of Geology and Geophysics.
C. Zheng, K. R. Bradbury, and M. P. Anderson.
Ground Water GRWAAR, Vol. 26, No. 6, p 734-742, November-December 1988. 10 fig, 2 tab, 16 ref.

Descriptors: *Solute transport, *Water quality management, *Pollution control, *Water pollution control, *Groundwater pollution, *Intercepting ditches, Agricultural chemicals, Aquifers, Simulation analysis, Groundwater barriers.

The groundwater pattern in the vicinity of an interceptor ditch used for agricultural drainage is simulated using flow and stream function models to explore the possibility of using interceptor ditches to control the spread of agricultural chemicals in shallow aquifers. The concept of the dividing streamline is used to quantify the effectiveness of the interceptor ditch for limiting the spread of potential contaminants. The simulation results suggest that the interceptor ditch may create an effective hydraulic barrier to the movement of agricultural contaminants in groundwater, but its effectiveness is subject to seasonal changes in hydrological conditions, including the regional water-table gradient, the distribution of recharge and discharge, and the ditch stage. A quantitative relationship between effectiveness of the ditch and these hydrological conditions is established. (Author's abstract)
W89-05877

EFFECT OF GROUNDWATER INTERCEPTION AND IRRIGATION ON SALINITY AND PIEZOMETRIC LEVELS OF AN AQUIFER,
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
F. Ghassemi, G. A. Thomas, and A. J. Jakeman.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 369-382, October-December 1988. 10 fig, 1 tab, 16 ref.

Descriptors: *Aquifers, *Rivers, *Groundwater management, *Water quality control, *Saline water intrusion, *Piezometry, Irrigation, Australia.

The major strategy used to prevent the discharge of highly saline groundwater to the River Murray in southeastern Australia is groundwater interception and disposal. The basic design principle assumes that the extraction of groundwater from an aquifer hydraulically connected to the river, using a line of pumps positioned close and roughly parallel to the river, will decrease piezometric heads, thereby reducing the discharge of saline groundwater to the river. The paper considers one of these schemes which was designed for the Mildura area on the basis of a hydrogeological investigation. It analyzes the effects on piezometric head and groundwater salinity due to the groundwater interception scheme and adjacent irrigation activity over a period of several years from January 1980. Piezometric heads have decreased significantly in the stretch close to the river. A slight reduction in groundwater salinity is also apparent in this stretch except for an area between the river and a holding basin used for disposal of the saline effluents emanating from the groundwater interception scheme. This general reduction in groundwater salinity is mainly caused by pumping from the groundwater interception scheme and recharge from irrigation. The exception in the trend in groundwater salinity is due to the movement of a highly saline body of groundwater from the holding basin towards the River Murray. Results of this Australian experience should be helpful to the designers of similar salinity mitigation schemes elsewhere. (Author's abstract)
W89-05891

ESTUARY REHABILITATION: THE GREEN BAY STORY,
Wisconsin Univ.-Madison. Sea Grant Inst.
For primary bibliographic entry see Field 4C.
W89-05909

RHODE ISLAND VOLUNTEERS MONITOR THE HEALTH OF SALT PONDS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
V. Lee.
Oceanus OCEAAK, Vol. 31, No. 3, p 44-48, Fall, 1988. 4 fig, 1 tab, 5 ref.

Descriptors: *Public ponds, *Ponds, *Marine environment, *Water quality, *Monitoring, *Rhode Island, Environmental policy, Resources management, Data acquisition, Water sampling, Turbidity, Nutrients, Bacterial analysis, Coastal zone management, Temperature, Wastewater management, Nonpoint pollution sources.

The use of trained volunteers for environmental monitoring is an excellent way to obtain certain kinds of reliable data in a cost-effective manner. Since 1985, 45 volunteers have been measuring water-quality parameters in seven of Rhode Island's salt ponds. These volunteers, representing a wide variety of backgrounds, were recruited from a core group who had participated in an earlier major research project on the salt ponds. Twice a month, from May through October, these pond watchers take water samples and measurements on turbidity and temperature, and conduct more sophisticated techniques such as filtering and storing samples for nutrients, chlorophyll, and bacterial analysis, conduct dissc!ved oxygen titrations, and monitor evidence of eelgrass-wasting disease. These pond watchers are providing useful information for government decision making and future scientific research. The bacteria monitoring has provided a successful link between the pond watchers and the Rhode Island Department of Environmental Management, the agency responsible for measuring water quality and policy decisions regarding closures of areas to shellfishing or swimming. Information from the pond watchers has aided another state agency, the Coastal Resources Management Council, which is responsible for planning and permitting development of the state's coastal zone. Pond watchers monitoring results are also incorporated into state reports to the EPA. The towns are using the data to develop policies for special wastewater management districts designed to decrease nonpoint source pollution loads. The success of the pond watchers project led to a symposium in 1988 which provided the first national forum to focus on the issues specific to citizen-monitoring programs. (Sand-PTT)
W89-05910

REDUCING WASTEWATER TOXICITY,
AWARE, Inc., Nashville, TN.
For primary bibliographic entry see Field 5D.
W89-05917

PILOT-SCALE EVALUATION OF ALUM TREATMENTS TO REDUCE LAKE SEDIMENT PHOSPHORUS RELEASE,
Clarkson Coll. of Technology, Potsdam, NY. Dept. of Civil and Environmental Engineering.
T. C. Young, A. G. Collins, and R. A. Armstrong.
Journal of Environmental Quality JEVQAA, Vol. 17, No. 4, p 673-676, October-December 1988. 2 fig, 1 tab, 16 ref.

Descriptors: *Eutrophic lakes, *Lake restoration, *Water pollution treatment, *Lake sediments, *Phosphorus, *Alum, Black Lake, New York, Water treatment, Mathematical studies.

A simple mass-balance approach to evaluate alum inactivation of sediment-bound phosphorus uses continuous-flow reactors and aerobic sediments from a eutrophic lake (Black Lake, NY). The method permitted tests of treatment effects on the rate and duration of sediment P release, was simple to interpret, statistically reliable, and could be applied to other eutrophic systems. Analyzed as a zero-order process, sediment P release rate decreased linearly as a function of alum dose, and the maximum dose tested (equivalent to 1.22 g Al/sq m) halved the zero-order P release rate for four hydraulic retention periods. (Author's abstract)
W89-05939

IMPACT OF SOURCE CONTROLS ON ACID RAIN LEVELS,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
E. A. McBean.
Journal of Energy Engineering JFEED9, Vol. 114, No. 3, p 99-106, December 1988. 1 fig, 6 tab, 6 ref.

Descriptors: *Water pollution control, *Acid rain, *Water pollution, *Air pollution effects, *Statistical analysis, *Seasonal variations, *Model studies, Deposition, Precipitation, Ontario, Ohio, Pennsylvania, Simulation analysis, Variability, Data collections, Emission reduction.

The University of Waterloo Long Range Transport Model is used to simulate the seasonal deposition levels attributable to emissions from Sudbury, Ontario, Central Ohio, and Western Pennsylvania. Recorded deposition data for three receptors are adjusted, reflecting a simulated emission reduction at the three sources. The impact of the reduction is not statistically significant, since the year-to-year variability exceeds the changes expected due to emissions reductions. A detailed data-normalization scheme that incorporates the data from all seasons (and possibly from multiple receptors) is required to provide the statistical resolutions necessary to recognize emission changes. The difficulty in recognizing selective emission reductions is demonstrated with simple statistical analyses on recorded and simulated data. The techniques applied to the raw database indicate that a record of 5 years is insufficient to detect statistically significant depositional changes due to 50% emission reductions at three major source groupings located in the vicinity of the Great Lakes. This failure is the result of seasonal variability in the recorded deposition data. Deseasonalization procedures succeeded in identifying statistically significant differences at two of the three receptor locations used in the analyses. Deseasonalization procedures appear to have promise as a means of augmenting the monitoring of records to demonstrate the effectiveness of emission control programs. (Miller-PTT)
W89-05954

GROWTH ANALYSIS OF WATER HYACINTH, EICHHORNIA CRASIPES SOLMS, IN DIFFERENT WATER TEMPERATURE CONDITIONS,
Osaka Prefectural Univ., Sakai (Japan). Faculty of Agriculture.
H. Sato.
Ecological Research, Vol. 3, No. 2, p 131-144, August 1988. 10 fig, 1 tab, 8 ref.

Descriptors: *Water pollution treatment, *Water hyacinth, *Temperature effects, *Plant growth, *Culturing techniques, Biomass, Growth rates, Logistic theory, Optimum factor, Water temperature, Mathematical studies.

A 40-day culture experiment of water hyacinth was made in 4 different water temperatures, 15, 20, 25, and 30 C, which were combined with 4 levels of concentration of culture solution, 1/3, 1, 3 and 9-fold of the standard solution containing 28 ppm of total N and 7.7 ppm of total P. The optimum condition for obtaining the maximum plant growth shifted from 30 C: 3-fold condition in the early stage to 20-25 C: 3-fold condition in the later stages of the experiment. The relation between the fresh weight biomass per 100-l tank and the concentration of culture solution was expressed successfully by a reciprocal equation. The relation between the biomass and water temperature was expressed by another reciprocal equation. The latter formula shows that the temperature can be treated as an exponential factor, and it suggests that the possibility of growth coefficient of the logistic growth equation being affected by temperature. (Author's abstract)
W89-05979

DEVELOPMENT OF BIOLOGICAL WATER QUALITY ASSESSMENT IN THE NETHERLANDS,
Limburg Water Pollution Control Authority, Roermond (Netherlands).
H. H. Tolkamp, and J. J. P. Gardeniers.
Hydrobiological Bulletin, Vol. 22, No. 1, p 87-91, 1988. 2 tab, 37 ref.

Descriptors: *Water quality, *The Netherlands, *Biological water quality, *Ecology, *Water quality management, Biological properties, History, Reviews.

Biological assessment of water quality in the Netherlands is reviewed and discussed in terms of the past, present and future. In the past, aquatic ecologists were mainly concerned with descriptive research, making inventories and describing taxonomy and autoecology of species. In the sixties, they moved to the problems of inland water management, including the study of running water using methods which assesses water quality according to the chemical and biological characteristics of the water into saprobic zones. Later, ecologists developed an assessment method based on macrophytes, made a system to assess the organic pollution of natural lowland streams (and added a numerical index to this system), developed a quality quotient for the assessment of large rivers, and presented a method for assessing large lakes by trying to integrate both saprobic and trophic aspects. The first edition of the Handbook of Biological Assessment of Water Quality was published in 1977 and the use of various methods has increased ever since. At present, the biological assessment of water quality is accepted as a normal tool in water quality management. But, now that the major sources of pollution have been eliminated, the water quality management aims at improving the quality of the aquatic ecosystem as a whole. The ecosystem includes both the water column itself and the interlinked system of water, bottom banks, and the animal and plant community that dwells there. (Miller-PTT)
W89-05988

WATER RESOURCES AND ENVIRONMENTAL POLLUTION IN NIGERIA: SOME PRELIMINARY FINDINGS,
Nigerian Inst. of Social and Economic Research, Ibadan.
For primary bibliographic entry see Field 5B.
W89-06004

RIVER MANAGEMENT TO REDUCE TURBIDITY IN NAVIGABLE BROADLAND RIVERS,
University of East Anglia, Norwich (England). School of Environmental Sciences.
P. N. Garrad, and R. D. Hey.
Journal of Environmental Management JEVMAW, Vol. 27, No. 3, p 273-288, October 1988. 8 fig, 2 tab, 34 ref.

Descriptors: *Water quality control, *Suspended load, *Turbidity, *Rivers, *Navigable waters, *Water management. Entrainment, Particle size, Suspended sediments, River beds, Bottom sediments, Algae, Macrophytes, Bank erosion, Boating.

The examination of the diurnal patterns of suspended sediment concentration in the River Bure (East Anglia) and of the size of particles held in suspension is described. It is suggested that forces greater than those exerted by the natural river and tidal flows are acting on the river bed. Correlation of boat traffic frequency with these patterns would suggest that the passage of many boats in succession throughout the day can cause entrainment of the soft bed sediments. The settling time for some of the material is long enough to suggest that boats have a daily as well as seasonal influence on the patterns of turbidity. Control of boat-induced turbidity can be achieved by reducing entrainment velocities for each boat type, which generally would imply a reduction in maximum permissible boat speed from 7 to 5 mph, or by enforcing a lag time between the passage of each boat. The former management option is the most practical to enforce. Recent work in Broadland has suggested that the algal populations are largely responsible for the high turbidity levels. Evidence that boat traffic can also affect turbidity suggests a need for reappraisal of management policies in Broadland to take account of boat speed and frequency as well as phytoplankton, if there is to be an effective recovery of the Broadland waterways. Reduction of turbidity should allow the reinstatement of the macrophyte populations, and thus aid protection of the river banks against further erosion. (Miller-PTT)
W89-06005

WATER POLLUTION CONTROL ADMINISTRATION IN JAPAN,
Environment Agency, Tokyo (Japan). Water Quality Bureau.
For primary bibliographic entry see Field 6E.
W89-06014

STRATEGIES FOR COASTAL WATER QUALITY MANAGEMENT: A CASE STUDY OF LAEM CHABANG (THAILAND) DEEP-SEA PORT DEVELOPMENT,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
S. Muttamara, and J. M. Baldisimo.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 221-228, 1988. 2 tab, 8 ref.

Descriptors: *Management planning, *Resources development, *Water quality control, *Water pollution control, *Coastal waters, *Thailand, *Port facilities, *Environmental impact statement, *Environmental effects, Harbors, Water quality management, Case studies, Water resources development, Marine environment.

An environmental study was conducted as a part of coastal water quality management for Laem Chabang Deep-Sea Port. It was revealed that the existing seawater quality at Laem Chabang area is generally well within standards for unpolluted seawater, making it suitable for fishing and recreation. Environmental impact assessment of the different activities to be carried out in relation to the Laem Chabang port development indicated that the following significant impacts on the marine environment can be anticipated: (1) direct damage to biological organisms by resuspension of organics due to disturbance of marine habitat during dredging/reclamation and breakwater/pier construction; (2) creation of high turbidity by disposal of dredge spoil which disturbs and/or smothers marine flora and fauna and, more importantly, poses the greatest threat to the tourism industry in Pattaya located about 12 km from the project site; (3) modification of the tidal current direction and velocity in the Laem Chabang bay as a result of dredging in the entrance channel, fairway and basin; (4) deterioration of seawater quality due to discharge of tapioca powder losses, domestic wastewater from port area and sewage from ships (5) destruction of the aesthetic aspects of the port waters and surrounding areas as a consequence of solid waste generation from cargo handling from ships. A number of strategies/measures for coastal water quality management to prevent or minimize the adverse impacts have been recommended. The proposed environmental protection program is necessarily justified considering the economic benefits to be gained by the country from port operations. (Author's abstract)
W89-06037

EFFECTS OF DEVELOPMENT OF A TIDAL BARRAGE UPON THE WATER AND SEDIMENT QUALITY OF THE MERSEY ESTUARY (U.K.) AND ITS BIOTA,
RPS Environmental Services Ltd., Mold (Wales).
For primary bibliographic entry see Field 6G.
W89-06038

WATER QUALITY MANAGEMENT OF THE HOOGHLY ESTUARY - A LINEAR PROGRAMMING MODEL,
Calcutta Metropolitan Development Authority (India).
S. K. Bose, P. Ray, and B. K. Dutta.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 235-242, 1988. 3 fig, 22 ref.

Descriptors: *Model studies, *Water quality management, *Estuaries, *Linear programming, *Mathematical models, Cost-benefit analysis, Water quality control, Model studies, Dissolved oxygen, Biochemical oxygen demand, India, Waste treatment.

Rapid and widespread deterioration of water quality in surface water systems has rendered mathematical modeling for predicting water quality indispensable especially in terms of bio-chemical oxygen demand (BOD) and dissolved oxygen (DO) under various system parameters. Model output under a prescribed set of conditions indicates the degree of treatment necessary to make the waste load acceptable. It also analyzes the consequences of changes in water quality objectives from a cost/benefit viewpoint. The most appropriate model in this regard would be the one which takes into account the cost of treatment plant installations and their locations. This paper proposes a linear programming model for water quality management of the Hooghly estuary. The linear objective function for the total cost of treatment at selected terminals has been expressed in terms of quantity of BOD removed. Computed data have been presented under reasonably wide range of parameters. (Author's abstract)
W89-06039

ROLE OF ESTUARINE MODELING IN NUTRIENT CONTROL,
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
W.-S. Lung.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 243-252, 1988. 7 fig, 10 ref.

Descriptors: *Estuaries, *Eutrophication, *Model studies, *Water quality control, Case studies, Limiting nutrients, Phosphorus, Nitrogen, Cyanophyta, Water quality management, Phytoplankton, Calibrations, Nonpoint pollution sources.

Two case studies are presented to demonstrate how estuarine water quality models can be used in planning eutrophication control. In the first study, a steady-state model is used to assess the impact of point source phosphorus reduction on the phytoplankton biomass in the upper James Estuary in Virginia during the summer months. The modeling results indicate that phosphorus is in ample supply to support the phytoplankton growth in the system. However, substantial reduction of loads by phosphorus removal at the wastewater treatment plants would lead to a phosphorus limiting condition thereby lowering the phytoplankton biomass levels. In the second study, a time-variable model is developed to investigate the potential of blue-green algal (Microcystis) blooms in the Neuse Estuary in North Carolina. More specifically, the model is designed to address two management questions. First, recognizing that high nonpoint nitrogen loads in the spring months would lead to a proliferation of non-nitrogen fixing blue-green genera, it was asked if parallel control of nitrogen should be considered. Second, in light of the potential for algae species dominance to shift, the possibility of control of nitrogen fixing blue-green algal blooms was questioned. Based on the modeling calibration results using data from 1983, 1984 and 1985 under different hydrologic conditions, freshwater flow to the estuary is found to be a key factor in controlling blue-green algal blooms in the Neuse Estuary. (Author's abstract)
W89-06040

SOME STUDIES TO REDUCE SEDIMENTATION IN A PORT ON A TIDAL RIVER,
Hanover Univ. (Germany, F.R.). Franzius-Inst. fuer Wasserbau und Kuesteningenieurwesen.
For primary bibliographic entry see Field 2J.
W89-06041

ROLE OF MODELLING IN THE CONTROL OF SEAWATER POLLUTION,
Port and Harbour Research Inst., Yokosuka (Japan). Marine Hydrodynamics Div.
T. Horie.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 277-286, 1988. 6 fig, 2 tab, 5 ref.

Descriptors: *Coastal waters, *Water pollution, *Water pollution control, *Water quality, *Seawater, *Model studies, Japan, Feasibility studies, Numerical analysis, Species diversity, Population density, Cycling nutrients, Sediments.

A feasibility study of seawater improvement projects in selected bays where seawater is highly polluted by organic substances is being conducted. The study includes field surveys in these bays of, for example, seawater quality, sediment characteristics, sediment release rate, sediment settling rate, organism growth rates, and biological activity. Numerical analysis of the situation is also being conducted, using a set of mathematical models. A water quality prediction model was formulated on the basis of phosphorus cycling between seawater, phytoplankton, and sediment. The results of the simulation predicted that the effect of seawater quality improvement would be unexpectedly small, because of dilution due to advection and dispersion by seawater circulation. However, in the field, ecological conditions seem to be significantly improved, given that the number of benthic species and the populations of these species increase on treated sediment, even though the improvement of water quality is less than expected. Based on these results, the author discusses the role of the numerical model and gives examples of its application in predicting the environmental improvement due to seawater quality improvement. (Author's abstract)
W89-06044

USE OF IN SITU MICROCOSMS FOR EVALUATING RESERVOIR WATER MANAGEMENT OPTIONS,
Nevada Univ. System, Las Vegas. Water Resources Center.
For primary bibliographic entry see Field 7B.
W89-06056

DISJUNCTIVE KRIGING AS AN APPROACH TO MANAGEMENT DECISION MAKING,
Agricultural Research Service, Riverside, CA. Salinity Lab.
For primary bibliographic entry see Field 6A.
W89-06073

'ECOSYSTEM' APPROACH TO MANAGING HUMAN USES AND ABUSES OF NATURAL RESOURCES IN THE GREAT LAKES BASIN,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
For primary bibliographic entry see Field 6A.
W89-06159

REDEVELOPMENT OF LAKE ECOSYSTEMS: A CASE-STUDY APPROACH,
Lund Univ. (Sweden). Inst. of Limnology.
S. Bjork.
Ambio AMBOCX, Vol. 17, No. 2, p 90-98, 1988. 1 fig, 35 ref.

Descriptors: *Lake restoration, *Dredging, *Lake sediments, *Water pollution treatment, Case studies, Water level, Eutrophication, Limnology, Environmental effects, Sedimentation, Sweden, Finland, Aquatic weed control, Nutrient removal.

Overloading of lakes by nutrients from external sources often creates long-term eutrophication problems. Even if the external loading is reduced to normal levels, internal loading from the nutrient-rich sediments can prevent recovery. Lake restoration refers to activities carried out in the lake itself in order to adjust the ecosystem. Ecosystem redevelopment concerns both lake restoration and all preparative work for normalizing the nutrient supply to water bodies from watershed and airshed. Methods to restore lakes irreversibly damaged by pollution or water-level-lowering are available. Redevelopment of degrading as well as severely degraded lakes and wetlands is exemplified by case studies from different latitudes. In Sweden the intensive construction of sewage treatment plants with phosphorus precipitation has improved the condition of numerous lakes. Several lakes are being redeveloped that have been damaged through pollution by sewage. Lake Trummen was restored through the dredging of nutrient-rich sediments. Lake Lillisjon was restored by sediment treatment in situ. Sewage and storm-flow water diversion helped to improve the condition of Lake Tunis, near Tunis on the Mediterranean Sea. The Lagoa Rodrigo de Freitas, Rio de Janeiro was restored by diverting sewage, removing sewage

sludge deposits, and cleaning up the shores for recreational purposes. The water level was raised to improve lake water quality in the Swedish Lake Hornborga. Dredged lake marl can be economically used as a liming element to offset stream acidification in many parts of Sweden. Of the Scandinavian countries, only Finland has a special department for lake redevelopment. Future planning for redevelopment should be based on a holistic view in the sense that whole drainage systems are included in programs for restoration and management. (Geiger-PTT)
W89-06162

BALTIC EUROPE, GREAT LAKES AMERICA AND ECOSYSTEM REDEVELOPMENT,
Gdansk Univ. (Poland). Dept. of Economic Geography of the Sea.
For primary bibliographic entry see Field 6G.
W89-06163

IMPORTANCE OF THE NEARSHORE AREA FOR SUSTAINABLE REDEVELOPMENT IN THE GREAT LAKES WITH OBSERVATIONS ON THE BALTIC SEA,
Wisconsin Univ.-Green Bay. Inst. for Land and Water Studies.
For primary bibliographic entry see Field 6A.
W89-06164

INSTITUTIONS AND ECOSYSTEM REDEVELOPMENT IN GREAT LAKES AMERICA WITH REFERENCE TO BALTIC EUROPE,
Waterloo Univ. (Ontario). Dept. of Environment and Resource Studies.
For primary bibliographic entry see Field 6E.
W89-06165

REHABILITATIVE REDEVELOPMENT OF THE FISH AND FISHERIES OF THE BALTIC SEA AND THE GREAT LAKES,
Toronto Univ. (Ontario). Dept. of Zoology.
For primary bibliographic entry see Field 8I.
W89-06166

ENERGY ANALYSIS APPROACH TO ECOSYSTEM REDEVELOPMENT IN THE BALTIC SEA AND GREAT LAKES,
Askoe Lab., Stockholm (Sweden).
For primary bibliographic entry see Field 6A.
W89-06167

USE OF TUBIFICIDS FOR WEEDING AND AQUACULTURE IN PADDY FIELDS IN JAPAN,
Tohoku Univ., Sendai (Japan). Biological Inst.
Y. Kurihara, and E. Kikuchi.
Journal of Tropical Ecology, Vol. 4, No. 4, p 393-401, November 1988. 3 fig, 4 tab, 9 ref.

Descriptors: *Water pollution prevention, *Rice paddies, *Tubificids, *Fertilizers, *Aquaculture, Aquatic weeds, Herbicides, Insecticides, Fish food organisms, Weed control, Japan.

Tubificid worms that live in rice paddy mud increase in numbers when an organic fertilizer is applied. The worms mix the soil by passing it through their gut as well as by their burrowing and respiratory movements, thereby checking the sprouting of paddy weeds. Tubificids inhabiting the pond's mud also serve as fish food. It is suggested that such a pond might by appropriate for aquaculture. A method to control paddy field ecosystems is presented based on the above findings to produce rice and freshwater fish, with organic fertilizers but without the use of herbicides and insecticides. Organic fertilizers, mainly compost, were applied to a paddy field with the water depth kept constant at 5-10 cm, and tubificids present in large numbers. Observations from June to September showed that: (1) after reaching about 30,000 worms per sq m in late June, the number of tubificids remained approximately constant; (2) the covering of weeds was below 5% during the period, suggesting that their growth was checked; and (3) the rice yield was 6000 kg/ha which is equal to or above average. (Geiger-PTT)
W89-06177

INFILTRATION AND HYDRAULIC CONDUCTIVITY OF A COMPACTED EARTHEN LINER,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5B.
W89-06199

CREATION OF AN ARTIFICIALLY PRODUCED FRACTURE ZONE TO PREVENT CONTAMINATED GROUND-WATER MIGRATION,
Dunn Geoscience Corp., Albany, NY.
K. F. Begor, M. A. Miller, and R. W. Sutch.
Ground Water GRWAAR, Vol. 27, No. 1, p 57-65, January-February 1989. 5 fig, 1 tab, 17 ref.

Descriptors: *Groundwater pollution, *Cleanup operations, *Geologic fractures, *Water pollution treatment, Pumping tests, Plumes, Groundwater movement, New York, Blasting, Recovery wells, Geohydrology.

To overcome difficulties associated with contaminated groundwater recovery at a site in upstate New York, an approach was developed that involved the creation of an artificial fracture zone through controlled blasting to intercept contaminated groundwater flow. Site investigations delineated the extent of a groundwater contamination plume migrating within a fractured bedrock aquifer (Medina sandstone) that underlines approximately 15 ft of glacial till. A 72-hr aquifer test involving one recovery well resulted in a low yield (3.5 gpm with 20 ft of drawdown). Data collected from adjacent observation wells indicated poor interconnection among naturally occurring features. Although the response of some observation wells mirrored that of the recovery well, others showed little or no response to pumping. Therefore, achieving the corrective action objectives (i.e., preventing further contaminant migration and removing and treating contaminated groundwater) would be difficult using a 'traditional' multiple recovery well system. It was decided that controlled linear blasting could provide the enhanced fracture interconnection necessary to successfully intercept the contaminated groundwater plume, which then would be capture and removed by judicious placement of recovery wells installed within the fracture zone. Using a carefully controlled, single-line pattern blasting technique, a 6-ft-wide, 300-ft-long fracture zone was created in the upper 25 ft of the bedrock aquifer, perpendicular to the centerline of the plume. Following fracturing, a second 72-hr aquifer test was conducted at the same location and under conditions similar to the first test. The second test indicated that the single recovery well located in the newly created fracture zone should be fully capable of recovering contaminated groundwater and preventing further migration of the plume. The recovery well produced a substantially higher yield of 18.5 gpm with only 11.2 ft of drawdown. Furthermore, all the nearby observation wells showed significant response to pumping. (Author's abstract)
W89-06205

COPRECIPITATION OF PHOSPHATE WITH CALCITE IN LAKE WATER: A LABORATORY EXPERIMENT MODELLING PHOSPHORUS REMOVAL WITH CALCITE IN LAKE CONSTANCE,
Konstanz Univ. (Germany, F.R.). Limnological Inst.
For primary bibliographic entry see Field 2K.
W89-06222

ALGAL BIOASSAYS IN EUTROPHICATION RESEARCH: A DISCUSSION IN THE FRAMEWORK OF A MATHEMATICAL ANALYSIS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
N. Nyholm, and J. E. Lyngby.
Water Research WATRAG, Vol. 22, No. 10, p 1293-1300, October 1988. 6 fig, 3 tab, 27 ref.

Descriptors: *Algae, *Mathematical analysis, *Water quality management, *Lake restoration, *Eutrophication, *Bioassay, *Limiting nutrients, Model studies, Kinetics, Algal growth, Liebigs Law, Nitrogen, Phosphorus, Management planning, Primary productivity.

The traditional growth potential algal bioassay with cultured algae was analyzed using a kinetic model and compared to short-term assays with indigenous phytoplankton. The different types of information obtained with the two techniques are discussed along with the concepts kinetic limitation (growth rate reduction) and yield limitation (Liebig's law limitation), respectively. From short-term tests with indigenous phytoplankton it can be determined which nutrient (e.g., N or P) is actually (kinetically) limiting at a given time, whereas growth potential tests can be used to determine which nutrient is limiting in the Liebig's law sense. Both types of information can be valuable in eutrophication studies. By analogy from batch culture algal assays to algal blooms in natural waters the model calculations indicate that in some situations available P may be depleted from the aqueous phase before available N, even if N provides the only significant nutrient limitation. Because the specific growth rate tends to be linearly related to the intracellular N concentration, whereas a hyperbolic relationship (saturation kinetics) exists for the dependence of specific growth rate on the intracellular P concentration, the intracellular P concentration can drop significantly without causing any significant reduction in growth rate, whereas a drop in intracellular N concentration causes a proportional drop in growth rate. A phenomenon like this could lead environmental managers to the erroneous conclusion that P is limiting (and therefore must be removed from wastewater) whereas N is the nutrient usually mainly responsible for limiting algal growth. (Rochester-PTT)
W89-06226

PHYTOPLANKTON AND PHOSPHORUS IN SOUTHERN GEORGIAN BAY, 1973-1982, AND IMPLICATIONS FOR PHOSPHORUS LOADING CONTROLS,
Ontario Ministry of the Environment, Rexdale. Water Resources Branch.
For primary bibliographic entry see Field 5B.
W89-06340

BENTHIC NEMATODES IN ACIDIFIED LAKES: CASE OF A NEGLECTED GRAZER,
Warsaw Univ. (Poland). Dept. of Hydrobiology.
For primary bibliographic entry see Field 5C.
W89-06352

AERATION OF LAKE MUTEK AS A METHOD OF RECULTIVATION: RANGE OF STUDIES AND LAKE MORPHOLOGY (NAPOWIETRZANIE JEZIORA MUTEK JAKO METODA REKULTYWACJI ZAKRES BADAN I MORFOLOGIA ZBIORNIKA),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
J. A. Szczerbowski.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 7-14, 1988. 1 fig, 2 tab, 17 ref. English summary.

Descriptors: *Water quality control, *Lakes, *Lake restoration, *Aeration, *Eutrophic lakes, *Lake Mutek, *Poland, Oxygenation, Morphology, Lake morphology, Destratification.

Lake Mutek is situated in the catchment area of the Sajna, Guber, Lyna and Pregola rivers, Poland. Its area is 10.7 ha; its maximal depth, 17.2 m. The lake has a poorly developed shore line. The southern part is very shallow. Two small inflows are present. The lake volume is slightly more than 400,000 cu m. About 65% of the total water volume lies within an isobath corresponding to the lake average depth. The depth index is 0.22 and the relative depth (0.0526) is very high. The lake study began in 1977, the control year. During the next two years the lake was aerated with one or two air compressors with a capacity of 16 cu m/h each. Air was compressed through a rubber hose, with a diameter of 23 mm, placed 1 m above the bottom

in the deepest part of the lake. Aeration done during 1978 from July 10 to September 6, with a break August 25-28, did not result in complete destratification. The 1979 aeration (March 14 to September 20) resulted in complete destratification. (See W89-06357 thru W89-06365) (Cassar-PTT)
W89-06356

CHANGES OF WATER CHEMISTRY INDUCED BY ARTIFICIAL AERATION OF LAKE MUTEK (ZMIANY CHEMIZMU WOD JEZIORA MUTEK POD WPLYWEM TRZYLETNIEGO SZTUCZNEGO NAPOWIETRZANIA),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
K. Lossow.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 15-38, 1988. 5 fig, 26 ref. English summary.

Descriptors: *Water quality control, *Lakes, *Lake restoration, *Aeration, *Oxygenation, *Eutrophic lakes, *Water temperature, *Lake Mutek, *Poland, Nutrients, Phosphorus, Nitrogen, Temperature, Organic matter, Hypolimnion, Metalimnion, Dissolved oxygen, Thermocline, Destratification, Calcium.

Physicochemical studies in Lake Mutek, Poland were carried out during a 3-yr aeration study. The lake was characterized by restricted mixing with oxygen deficits in the deep, cold hypolimnion. From May until mid-October the deeper water layers contained only traces of oxygen. Maximum levels of chemical constituents (in mg/cu dm) were as follows: phosphorus, 1.17; nitrogen, 4.57; organic matter, 17 (as BOD); iron, 3.8 manganese, 2.10; and calcium, 99.2. The lake was classified as eutrophic, with a tendency toward alkalinity. The first year of aeration resulted in lowering of the thermocline by 8 m. In the next two years no thermocline was formed. The temperature of the former metalimnion and hypolimnion increased considerably; by the end of the summer the deepest water layers were 10 C warmer than in the pre-experimental period. Some thermal differences between surface and bottom water layers were still observed during summer (water stability did not reach zero). Consequently, oxygen conditions improved less than was expected. The warmer temperatures increased the decomposition rate of the organic matter. Nevertheless, the duration of oxygen deficit was shorter. Organic matter increased in the surface layer and decreased in other water layers. Contents of organic phosphorus and nitrogen also increased, whereas phosphates and ammonia nitrogen decreased. In spring, the pH of surface waters increased; in summer, it decreased. An unexpected drop in calcium levels and water alkalinity was seen. No changes were observed in chloride levels or water transparency. (See also W89-06356 and W89-06358 thru W89-06365) (Cassar-PTT)
W89-06357

CHEMISTRY OF BOTTOM SEDIMENTS IN LAKE MUTEK INDUCED BY ARTIFICIAL AERATION (CHEMIZM OSADOW DENNYCH JEZIORA MUTEK PODDANEGO EKSPERYMENTOWI SZTUCKZNEGO NAPOWIETRZANIA),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
H. Gawronska.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 39-52, 1988. 5 fig, 2 tab, 35 ref. English summary.

Descriptors: *Lake restoration, *Water quality control, *Eutrophic lakes, *Lake Mutek, *Poland, *Lakes, *Sediments, *Aeration, Oxygenation, Destratification, Lake sediments, Bottom sediments, Organic matter, Nitrogen, Phosphorus, Silica, Iron, Manganese, Calcium, Magnesium, Aluminum, Calcium carbonate.

The influence of artificial aeration on the chemical composition of the bottom sediments (0 - 40 cm layer) in Lake Mutek was studied. Samples were collected at 13 stations, 18 samples in 1977 and 102 samples in 1979. Little difference was observed in sediments with respect to spatial and vertical distribution of the components of interest, which were typical of those in a eutrophic lake. Silica, organic matter and calcium accounted for 70-79% (dry weight) of the sediment. Significant correlation was found between nitrogen and organic matter, indicating that nitrogen was accumulated mainly in the form of organic matter. The relationships between phosphorus and iron and between phosphorus and manganese showed the role of these two elements in phosphorus removal from lake water. Calcium carbonate deposition was also demonstrated. The changes in bottom sediment chemistry produced by artificial aeration were insignificant. However, in shallow areas, increased mineralization was evident. (See W89-06356 thru W89-06357 and W89-06359 thru W89-06365) (Cassar-PTT)
W89-06358

EFFECT OF ARTIFICIAL LAKE DESTRATIFICATION ON CHANGES OF PHYTOPLANKTON BIOMASS (WPLYW SZTUCZNEJ DESTRATYFIKACJI JEZIORA NA ZMIANY BIOMASY PLANKTONU ROSLINNEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
M. Rybak.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 53-70, 1988. 2 fig, 5 tab, 58 ref. English summary.

Descriptors: *Eutrophic lakes, *Lake Mutek, *Poland, *Lake restoration, *Water quality control, *Lakes, *Aeration, *Phytoplankton, Oxygenation, Destratification, Algae, Phosphorus, Nutrients.

In 1977-1980 studies were carried out in Lake Mutek, Poland on the effect of artificial destratification caused by aeration upon changes of phytoplankton biomass. Studies carried out in a control year 1977 and in experimental years 1978-1980 showed that artificial destratification resulted in noticeable changes in phytoplankton development. During lake aeration in 1978 algal biomass increased two-fold, and in 1979, almost four-fold, compared with the control year. Only in 1980 did the phytoplankton biomass decrease. In this year meteorological conditions were different. Based on results obtained in 1977-1979, several factors were defined as favorable to increased algal development: proper selection of aerating devices, adapted to lake size; enhancement of nutrient turnover, especially phosphorus; improvement of radiation utilization by algae; and optimal conditions for the development of Ceratium hirundinella. (See W89-06356 thru W89-06358 and W89-06360 thru W89-06365) (Cassar-PTT)
W89-06359

PHYTOPLANKTON OF AN ARTIFICIALLY AERATED LAKE MUTEK (PLANKTON ROSLINNY JEZIORA MUTEK PODDANEGO SZTUCZNEMU NAPOWIETRZANIU HYPOLIMNIONU),
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Zaklad Rybactwa Stawowego.
J. Sosnowska.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 71-101, 1988. 6 fig, 2 tab, 34 ref. English summary.

Descriptors: *Lake restoration, *Water quality control, *Lakes, *Aeration, *Phytoplankton, *Eutrophic lakes, *Lake Mutek, *Poland, Oxygenation, Destratification, Ceratium, Diatoms.

The efficiency of artificial aeration of eutrophic Lake Mutek was evaluated by observation of phytoplankton collected at monthly intervals throughout 1977-1979. Results were as follows: (1) Phytoplankton biomass almost doubled during the aeration. Ceratium hirundinella caused blooms. (2) Biomass increased only in summer during aeration. In spring algal abundance remained low, although diatoms were usually present. (3) Aeration caused a change in dominant species, from Dinophyceae and Bacillariophyceae in the control year to Dinophyceae in the experimental years. (4) Aeration did not change the seasonal patterns of algal abundance. The lake underwent progressive eutrophication during the aeration experiments, as supported by the following observations. (1) Phytoplankton taxa decreased from 260 to 213. (2) Nygaard's complex index increased from 8.1 to 12.7. (3) The average annual standing crop of algae per square meter increased from 3.7 to 11.6 mg/cu dm. (4) The maximal algal biomass per square meter increased from 11 to 25 mg/cu dm. (5) Prolonged summer blooms of Ceratium hirundinella developed and intensified during aeration. (6) The nanoplankton fraction in the phytoplankton was reduced, with simultaneous increase of the larger forms. (See W89-06356 thru W89-06359 and W89-06361 thru W89-06365) (Cassar-PTT)
W89-06360

CHARACTERISTICS OF MORE IMPORTANT SPECIES OF HYDROMACROPHYTES AND THEIR BIOMASS IN A RECULTIVATED LAKE MUTEK (CHARAKTERYSTYKA WAZNIEJSZYCH GATUNKOW HYDROMAKROFITOW I ICH BIOMASY W REKULTYWOWANYM JEZIORZE MUTEK),
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Dept. of Pond Management.
J. Radziej.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, 103-114, 1988. 3 fig, 3 tab, 13 ref. English summary.

Descriptors: *Lake restoration, *Water quality control, *Lakes, *Aeration, *Macrophytes, *Aquatic plants, *Eutrophic lakes, *Lake Mutek, *Poland, Oxygenation, Destratification, Floating plants, Spatterdock, Phragmites, Water lily, Cat tails, Sweetflag, Pondweed, Water milfoil, Nuphar luteum, Nymphea alba.

Macrophytes were studied in Lake Mutek before and after aeration to produce destratification. Emergent vegetation was dominated by common reed (Phragmites communis). Small groups of cat tail, Carex sp., sweetflag, Rumex hydrolapatum and Equisetum limnosum were also present. Emergent vegetation occupied 9.3% of total lake area. Reed was growing at densities of 20-132 plants/sq m. Its biomass increased from 14,317 kg in 1977 to 18,502 kg in 1980. Submerged and floating plants (dominated by spatterdock and water lily) occupied about 40% of the total lake area. Spatterdock was found at a depth of 1.5-2.5 m, forming a ring between the littoral and pelagic regions. Its biomass increased from 21,823 kg in 1977 to 27,083 kg in 1980, constituting 71% of the biomass of submerged and floating plants and 47% of total macrophyte biomass. Water smartweed was also abundant in shallow parts of the lake. Species growing in low abundance were pondweed, water milfoil, and coontail. Nuphar luteum formed a community with Nymphea alba, characteristic of vegetation in a shallow, strongly euphotic lake. (See W89-06356 thru W89-06360 and W89-06362 thru W89-06365) (Cassar-PTT)
W89-06361

BACTERIOLOGICAL WATER QUALITY OF AN ARTIFICALLY DESTRATIFIED LAKE (CZYSTOSC BAKTERIOLOGICZNA WODY JEZIORA SZTCUZNIE DESTRATYFIKOWANEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
S. Niewolak.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 115-154, 1988. 10 fig, 9 tab, 38 ref. English summary.

Descriptors: *Eutrophic lakes, *Lake Mutek, *Poland, *Lake restoration, *Water quality control, *Lakes, *Aeration, *Bacteria, Oxygenation, Bottom sediments, Sediments, Lake sediments, Destratification, Microbiological studies, Coliforms, Rainfall, Runoff.

Microbiological studies were carried out in Lake Mutek in 1977-1980 to reveal the effects of aeration and destratification on water quality. Samples were collected from lake water, sediments, inflow and outflow, as well as one series of soil samples in nearby pastureland. Only 10-20% of the water samples were noticeably polluted; these had been collected after heavy rainfalls. The fecal coliform:fecal streptococci ratio was <0.7 in 84% of the water samples, showing that the source of pollution was animal feces and soil bacteria. Bottom sediments contained 100-1000 times the bacteria as did the lake water. The vertical distribution of bacteria in lake water during the summer stagnation of 1977 and 1978 was typical of eutrophic lakes. In 1979 and 1980 the aeration and destratification produced a cluster pattern of bacterial distribution, which was affected by ultraviolet bactericidal action, turbulence from the aeration, and vertical layering of the zooplankton. Seasonal variation of indicator bacteria showed a 10 to 100-fold increase in spring during snowmelt and a 100 to 1000-fold increase in spring, summer and autumn during heavy rainfalls. Water quality in Lake Mutek deteriorated during the first two years of aeration due to movement of bacteria from the bottom sediments to the lake water. In the last year of the study (1980) water quality had noticeably improved. (See W89-06356 thru W89-06361 and W89-06363 thru W89-06365) (Cassar-PTT)
W89-06362

MICROBIOLOGICAL STUDY OF AN ARTIFICIALLY DESTRATIFIED LAKE (MIKROBIOLOGICZNE BADANIA JEZIORA SZTUCZNIE DESTRATYFIKOWANEGO),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 2H.
W89-06363

ZOOPLANKTON IN ARTIFICIALLY AERATED LAKE MUTEK IN THE PERIOD 1977-1980 (ZOOPLANKTON SZTUCZNIE NAPOWIETRZANEGO JEZIORA MUTEK W LATACH 1977-1980),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
J. Widuto.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 173-185, 1988. 4 fig, 2 tab, 34 ref. English summary.

Descriptors: *Eutrophic lakes, *Lake Mutek, *Poland, *Lake restoration, *Water quality control, *Lakes, *Fisheries, *Aeration, *Zooplankton, Invertebrates, Oxygenation, Destratification, Fish, Seasonal variation, Rotifers.

Zooplankton were surveyed before and during aeration of Lake Mutek during a four-year program to establish a more intensive fishery. Fish introduced were Hypophthalamicthys molitrix Val., Coregonus peled Gmelin, Cyprinus carpio L. The following conclusions were drawn from the zooplankton species composition, numbers, biomass seasonal patterns, and vertical distribution data: (1) Species composition, abundance and biomass of the zooplankton were characteristic of a highly eutrophic lake. Species indicative of eutrophy were present (Bosmina longirostris, Mesocyclops leukarti, Thermocyclops oithonoides, Keratella cochlearis Gosse, Brachionus angularis bidens Plate, Pompholyx sulcata Huds, Pompholyx complanata Gosse). (2) Aeration was the most important factor in seasonal patterns of the number and biomass of zooplankton as a whole and in the species distribution. (3) During aeration the biomass of planktonic crustaceans was almost twice that of the control year (3.7 mg/liter). (4) The biomass of planktonic rotifers remained at the same level (0.7 mg/liter) throughout the experiment. (5) The zooplankton range deepened in winter and summer because of improved oxygen conditions in the deeper layers. (6) During aeration species characteristic of less trophic waters were seen. (7) The great abundance and biomass of zooplankton as well as a favorable distribution in the water column point to more intensive fishery management of Lake Mutek. (See W89-06356 thru W89-06363 and W89-06365) (Cassar-PTT)
W89-06364

CHANGES IN FISHERY PRODUCTION OF LAKE MUTEK (ZMIANY PRODUKCJI RYBACKEIJ JEZIORA MUTEK),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
J. A. Szczerbowski, and A. Martyniak.
Polish Agricultural Annual, Series H, Fisheries, Vol. 101, No. 1, p 187-204, 1988. 5 fig, 4 tab, 21 ref. English summary.

Descriptors: *Lake restoration, *Water quality control, *Lakes, *Fisheries, *Aeration, *Eutrophic lakes, *Lake Mutek, *Poland, Oxygenation, Destratification, Pike, Bream, Rudd, Carp, Roach, Growth rate, Zooplankton, Fish populations.

Fish catches before aeration of Lake Mutek were dominated by bream, white bream, pike, and rudd. In the first year of aeration (1979) bream, white bream, and carp were dominant. In 1980 bream and white bream were most numerous and constituted the highest biomass. Pike numbers decreased from 1978 (49.1 kg/ha) to 1980 (12.8 kg/ha); on the other hand its rate of growth increased. The number and mass of bream and white bream visibly increased, but the average individual weight of fishes decreased by more than 6-fold, probably a result of high population density. The number of roach increased considerably, but its rate of growth also increased. Numbers of rudd decreased, but its rate of growth increased. The increase in growth rate of rudd and roach was explained by the increased abundance of zooplankton. The catchable fraction of pike in 1978 amounted to 62 kg/ha. In spring 1979 common carp was introduced into the lake. During the two subsequent years 75.5% of this carp was caught. However, carp stocking in 1980 was unsuccessful, as was stocking with peled. (See W89-06356 thru W89-06364) (Cassar-PTT)
W89-06365

LIMING TO MITIGATE ACIDIFICATION IN FRESHWATER ECOSYSTEMS: A REVIEW OF THE BIOLOGICAL CONSEQUENCES,
University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
N. S. Weatherley.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 421-437, June 1988. 114 ref.

Descriptors: *Acid rain effects, *Water pollution treatment, *Lime, *Limnology, Acidification treatment, Running waters, Ecological effects.

The use of lime to mitigate the biological effects of surface water acidification, has recently become a widespread practice. Following a background section on liming strategies and physicochemical effects, the observed effects of this treatment on the decomposition process and major biological components of freshwater ecosystems are reviewed. Available studies, which cover up to about 6 to 8 yr post-treatment, describe many positive biological responses to liming. These include population expansion of acid-sensitive plant and animal species, and restoration of fisheries. However, no ecosystems have so far been returned to pre-acidification status, and possible reasons for this are discussed. The frequent persistence of acid episodes in limed waters may adversely affect some species. Reductions in available P and dissolved organic C may also be limiting factors, while precipitated metal hydroxides are potentially toxic. When physicochemical conditions are favorable, biological recovery may be restricted by other factors, including colonization rates and the reduced genetic diversity of small residual founding populations. If the long-term ecological consequences of liming are to be predicted, further understanding of these limitations and the stability properties of aquatic communities is necessary. (Author's abstract)
W89-06396

LAND USE CONSIDERATIONS IN REDUCING OIL AND GREASE IN URBAN STORMWATER RUNOFF,
Bowling Green State Univ., OH.
G. S. Silverman, M. S. Stenstrom, and S. Fam.
Journal of Environmental Systems JEVSB, Vol. 18, No. 1, p 31-48, 1988-89. 2 fig, 7 tab, 27 ref.

Descriptors: *Storm runoff, *Water pollution sources, *Water pollution prevention, *Mathematical models, *Oil pollution, Drainage area, Hydrocarbon, Land use, Urban areas, San Francisco Bay, Urban runoff, Highways.

The input of oil and grease (hydrocarbons) to San Francisco Bay from the local drainage areas is described. Results of two earlier experimentally based studies were used to develop the parameters for a material balance model for the entire San Francisco Bay local drainage area. Land use data and growth scenarios were determined from census data and local government projections. Total oil and grease emissions are estimated for several scenarios, including growth until the year 2000. Present emissions from urban runoff appear to be slightly less than point source emissions. For the anticipated growth occurring over the next 15 years, the model predicts an 8 yr 15% increase in oil and grease emissions depending on the rainfall conditions. Techniques designed to limit the release of oil and grease from commercial/industrial areas, which have a disproportionate impact on oil and grease loading in the Bay area, offer more promise than traditional control measures which work best for a uniform flow. Reducing sporadically high discharges to the watershed can result in major decreases in overall loading. (Brock-PTT)
W89-06401

ENVIRONMENTAL IMPACTS AND REGULATORY POLICY IMPLICATIONS OF SPRAY DISPOSAL OF DREDGED MATERIAL IN LOUISIANA WETLANDS,
Louisiana State Univ., Baton Rouge. Center for Wetland Resources.
For primary bibliographic entry see Field 5E.
W89-06404

NARRAGANSETT BAY POLLUTION CONTROL: AN EVALUATION OF PROGRAM OUTCOME,
Rhode Island Univ., Kingston. Dept. of Marine Affairs.
R. H. Burroughs, and V. Lee.
Coastal Management CZMJBF, Vol. 16, No. 4, p 363-377, 1988. 1 tab, 6 fig, 37 ref. NOAA/Grant NA85AA-D-SG094.

Descriptors: *Wastewater treatment, *Water quality management, *Water pollution control, *Estuaries, *Narragansett Bay, *Rhode Island, Bays, Dissolved oxygen, Water quality, Statistical analysis.

Point source loadings of oxygen demanding organic material and ambient conditions of bottom water dissolved oxygen were examined over recent decades to determine the effects of a sewage treatment plant in reducing pollution in Narragansett Bay. Two tests of program outcome were used for the evaluation. The first test demonstrated that a statistically significant increase in bottom water dissolved oxygen was correlated with a sewage treatment plant upgrade rather than some other reason. The results demonstrated that enhanced sewage treatment was the cause of an improvement in dissolved oxygen, one measure of ambient water quality. The second analysis showed that these improvements in water quality exceed those that could be attributed to improved background conditions caused by reduced loading from the major river by demonstrating that estuarine segments still receiving combined sewer overflows and possibly loads from small tributaries did not exhibit improved bottom water dissolved oxygen levels. It was concluded that present conditions of bottom water dissolved oxygen, although improved throughout much of the upper estuary, are not sufficient to meet desirable standards. (Author's abstract)
W89-06405

DER WETLANDS PROTECTION ACTION PLAN,
Pennsylvania Dept. of Environmental Resources, Harrisburg.
For primary bibliographic entry see Field 6E.
W89-06406

EFFECT OF SELECTED DYES ON THE GROWTH OF DUCKWEED,
University of South Florida, Tampa. Dept. of Chemistry.
For primary bibliographic entry see Field 4A.
W89-06410

MODEL FOR IRREVERSIBLE ADSORPTION HYSTERESIS,
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil and Ocean Engineering.
For primary bibliographic entry see Field 5B.
W89-06411

INFILTRATION THROUGH LAYERED-SOIL TRENCH COVERS: RESPONSE TO AN EXTENDED PERIOD OF RAINFALL,
Illinois State Geological Survey Div., Champaign.
T. H. Larson, D. A. Keefer, K. A. Albrecht, and K. Cartwright.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 251-261, December 1988. 9 fig, 11 ref.

Descriptors: *Water pollution prevention, *Waste disposal, *Trenches, *Wick systems, Silt, Loam, Infiltration, Gravel, Rainfall, Laboratory equipment.

Four experimental waste disposal trench covers were constructed to test the effectiveness of layered-soil cover designs in reducing infiltration. Three covers each consisted of a layer of gravel between an overlying wick layer of compacted fine-grained material (either silt or loam) and a compacted loam base; the fourth consisted of compacted silt over a loam base. Capillary pressures were monitored at various depths within each cover during October through December, 1985, a period of high rainfall following a dry summer. Moisture movement in response to the rainfall was rapid within the upper layers of all four test covers, but was retained within the upper layers of the three wick-system trenches, despite variations in the design thickness and composition of the wick layers. In the wick systems, moisture did not enter the gravel until a threshold level of pressure approaching saturation was established in the wick layer. Once this level was reached, moisture moved into and through the gravel. This experiment demonstrates the functionality of field-scale wick systems. (Author's abstract)
W89-06428

STREAMFLOW AND STREAM SALINITY IN A SMALL WATER SUPPLY CATCHMENT IN SOUTHWEST WESTERN AUSTRALIA AFTER REFORESTATION,
Water Authority of Western Australia, Perth.
For primary bibliographic entry see Field 2E.
W89-06462

LINEAR PROGRAMMING FOR ABATEMENT OF NITROGEN OXIDES ACID RAIN DEPOSITION,
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 5B.
W89-06489

PREVENTION AND REMEDIATION OF CONTAMINATED SITES WITH LININGS,
Butek Ltd., Essex (England).
For primary bibliographic entry see Field 5D.
W89-06494

LOGNORMAL KRIGING FOR THE ASSESSMENT OF RELIABILITY IN GROUNDWATER QUALITY CONTROL OBSERVATION NETWORKS,
Universidad Politecnica de Cataluna, Barcelona (Spain).
For primary bibliographic entry see Field 7A.
W89-06512

WATER QUALITY CHARACTERISTICS IN ELECTRO-DAM RESERVOIRS (OSOBENOSTI FORMIROVANIYA KACHESTVA VODY V VODOKHRANILISHCHAKH ENERGOKOMPLEKSOV),
Ukrainskii Nauchno-Issledovatel'skii Inst. Gidroproekt, Kharkov (USSR).
For primary bibliographic entry see Field 2H.
W89-06563

GOING WITH THE FLOW: USDA'S DUBIOUS COMMITMENT TO WATER QUALITY,
A. Rosenthal.
Environmental Forum ENVFEN, Vol. 5, No. 4, p 15-18, September/October 1988.

Descriptors: *Administrative agencies, *Operating policies, *Water quality control, *Agricultural runoff, Policy making, Nonpoint pollution sources, Soil conservation, Remaining, Liability.

Among the plethora of environmental hazards recognized today, agricultural runoff is one of the worst. Unfortunately, it is also one that has been seriously neglected by the federal government. Recent events and policies within the U.S. Department of Agriculture (USDA)--the primary oversight agency--raise fundamental questions about its commitment to resolving the nonpoint source problem. Perhaps the most dramatic turnaround by USDA was in its implementation of the 'Conservation Compliance' provisions of the Food Security Act (FSA) of 1985. USDA policies and practices relating to this act are discussed. Beyond Conservation Compliance, there are other FSA programs that could be tailored to produce water quality benefits but have not been utilized by USDA for this effect. USDA's dubious record in implementing the FSA programs is surprising, not just because it appears to contravene legislative intent, but because it contrasts so blatantly with the public rhetoric espoused by the Soil Conservation Service. Today, while the USDA still maintains primary authority over the agricultural community, it would do well to pursue a more vigorous environmental orientation in implementing its programs. In attempting to spare farmers from modifying farm practices, USDA may not only be causing irreversible harm to surface and groundwater bodies and critical aquatic habitats; in the long run it may be doing a disservice to the agricultural community it seeks to protect. American farmers will be drinking tomorrow the very water that they pollute today. (VerNooy-PTT)
W89-06590

REMINING AND THE WATER QUALITY ACT OF 1987: OPERATORS BEWARE,
Reed, Smith, Shaw and McClay, Pittsburgh, PA.
For primary bibliographic entry see Field 6E.
W89-06592

SOURCE REDUCTION OF TOXIC WASTE: IMPLICATIONS FOR WESTERN WATER POLICY,
Southern California Metropolitan Water District, La Verne.
C. Boronkay.
Columbia Journal of Environmental Law CJELE8, Vol. 13, No. 1, p 285-291, 1988. 13 ref.

Descriptors: *Toxic wastes, *Water pollution prevention, *California, *Water policy, *Chemical wastes, Water pollution control, Industrial wastes, Policy making, Water resources institutes, Groundwater pollution.

The water industry has a major stake in dealing with the problem of toxic wastes. It is simple common sense that source reduction must be an important part of any comprehensive groundwater quality control strategy. The dimensions of the groundwater quality problem is defined from the perspective of one of the largest suppliers of municipal and industrial water in the nation, the Metropolitan Water District of Southern California (Metropolitan). Also summarizes briefly an innovative joint effort with an old adversary, the Environmental Defense Fund (EDF) to improve the chances of implementing source reduction to deal with future contamination episodes before they get started. The Source Reduction Research Partnership (SRRP) is intended to facilitate the protection of groundwater basins from future contamination by looking hard and objectively at the practical issues involved in the application of the theoretically attractive idea of source reduction. The study is expected to produce an unprecedented data base that will facilitate decision making by regulated firms and regulatory agencies, and that will prove highly valuable in long range water planning. (VerNooy-PTT)
W89-06593

CITIZEN PARTICIPATION AND ADMINISTRATIVE DISCRETION IN THE CLEANUP OF NARRAGANSETT BAY,
For primary bibliographic entry see Field 6E.
W89-06596

REGULATING DISCHARGES INTO GROUNDWATER: THE CRUCIAL LINK IN POLLUTION CONTROL UNDER THE CLEAN WATER ACT,
For primary bibliographic entry see Field 6E.
W89-06597

WATER POLLUTION LAW: PLUGGING THE LEAKS,
For primary bibliographic entry see Field 6E.
W89-06599

RIVER POLLUTION: A CASE FOR A PRAGMATIC APPROACH TO ENFORCEMENT,
Dundee Univ. (Scotland). Dept. of Law.
For primary bibliographic entry see Field 6E.
W89-06600

DECAYING LAKES: THE ORIGINS AND CONTROL OF CULTURAL EUTROPHICATION,
B. Henderson-Sellers, and H. R. Markland.
John Wiley and Sons, New York. 1987. 254p.

Descriptors: *Urban hydrology, *Eutrophication, *Lakes, *Water pollution control, *Water pollution effects, Algal growth, Biomass, Nutrients, Primary productivity, Reservoirs.

The natural phenomenon of eutrophication normally occurs over a period of centuries, though some lakes have recently experienced a dramatic increase in this rate, creating eutrophic conditions within decades or less. Elevated nutrient levels in water allow biomass productivity to increase, causing water quality to deteriorate. This accelerated eutrophication is caused mainly by man's activities in the catchment area. This book provides a comprehensive introduction to the subject of eutrophication of lakes and reservoirs and is divided into three main parts. The first looks at the basic causes and control strategies; the second introduces the current conflict between the natural environment and man's disturbance of it through the discharge of leached agricultural fertilizers and treated wastewater; the third part presents the current scientific basis of understanding the processes of eutrophication and its control. (Lantz-PTT)
W89-06629

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 4. APPENDIX A-1 (CONTINUED).
Radian Corp., Austin, TX.
Available from National Technical Information Service, Springfield, VA 22161, as AD-A190 444. Price codes: A99 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 302p. USAF Contract No. F33615-83-D-4001.

Descriptors: *Cleanup operations, *Data collections, *Water quality, *Groundwater quality, *Surface water, Water sampling, Water analysis, Volatile organic compounds, Organic compounds, Hydrocarbons, Pesticides, Polychlorinated biphenyls, Aromatic compounds, Metals.

This volume presents data in 'Appendix A-1' of Installation Restoration Program. Phase II - Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas. Volume 4. It contains data concerning groundwater and surface water samples (logs and cross references), analyzed for hydrogenated volatiles, aromatic volatiles, pesticides, polychlorinated biphenyls, acidic volatiles, and metals. (See W89-06634 thru W89-06638) (Lantz-PTT)
W89-06633

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 5. APPENDIX A-2.
Radian Corp., Austin, TX.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A190 445. Price codes: A22 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 468p. USAF Contract F33615-83-D-4001.

Descriptors: *Cleanup operations, *Water quality, *Groundwater quality, *Surface water, Water sampling, Water analysis, Volatile organic compounds, Organic compounds, Hydrocarbons, Pesticides, Polychlorinated biphenyls, Aromatic compounds, Metals.

This volume presents data in 'Appendix A-2', of Installation Restoration Program. Phase II- Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas. Volume 5. of which contains data concerning groundwater and surface water samples (logs and cross references), analyzed for hydrogenated volatiles, aromatic volatiles, pesticides, polychlorinated biphenyls, acidic volatiles, and metals. Data for all quality assurance and quality control reports for the water analyses are organized by work order number. Also included are summary tables. (See also W89-08663 and W89-06635 thru W89-06638) (Lantz-PTT)
W89-06634

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 6. APPENDIX A-2 (CONTINUED).
Radian Corp., Austin, TX.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A190 446. Price codes: A18 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 488p. USAF Contract F33615-83-D-4001.

Descriptors: *Cleanup operations, *Data collectiosn, *Water quality, *Groundwater quality, *Surface water, Water sampling, Water analysis, Volatile organic compounds, Organic compounds, Hydrocarbons, Pesticides, Polychlorinated biphenyls, Aromatic compounds, Metals.

This volume presents a continuation of the data in 'Appendix A-2', of Installation Restoration Program. Phase II - Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas. Volume 6. Volume 5, which contains data concerning groundwater and surface water samples (logs and cross references), analyzed for hydrogenated volatiles, aromatic volatiles, pesticides, polychlorinated biphenyls, acidic volatiles, and metals. Data for all quality assurance and quality control reports for the water analyses are organized by work order number. Also included are summary tables. (See W89-06633 thru W89-06634 and W89-06636 thru W89-06638) (Lantz-PTT)
W89-06635

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 8. APPENDICES B-E.
Radian Corp., Austin, TX.
Available from National Technical Information Service, Springfield, VA 22161, as AD-A190 448. Price codes: A06 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 106p. USAF Contract F33615-83-D-4001.

Descriptors: *Water quality, *Cleanup operations, *Data collections, *Groundwater quality, *Surface water, Water sampling, Water analysis, Core logs, Well logging, Lithologic logs.

This volume presents data in 'Appendices B-E' of Installation Restoration Program. Phase II - Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas. Volume 8, which contains data concerning the: (B) Definitions, nomenclature, and units; (C) Statement of work; (D) Well number system; and (E) Lithologic logs - soil boring logs, well logs, soil boring completion logs, and well completion logs, for the data presented on groundwater and surface water samples (logs and cross references). (See W89-06633 thru W89-06635 and W89-06637 thru W89-06638) (Lantz-PTT)
W89-06636

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 9. APPENDICES F-K.
Radian Corp., Austin, TX.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A190 449. Price codes: A14 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 348p. USAF Contract F33615-83-D-4001.

Descriptors: *Cleanup operations, *Data collections, *Water quality, *Groundwater quality, *Surface water, Water sampling, Water analysis, Quality controls, Biographies, Conductivity, Soil gas, Personnel.

This volume presents data in 'Appendices F-K' of Installation Restoration Program. Phase II - Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas, Volume 9. Installion which contains data concerning the: (F) Sampling and analytical procedures (field investigation quality control plan and quality assurance/quality control program for Radian analytical services); (G) References; (H) Biographies of key personnel; (I) Results of terrain conductivity and soil gas surveys, terrain conductivity survey, and shallow soil gas investigation; (J) Health and safety plan; and (K) Technical operations plan. These data were analyzed for hydrogenated volatiles, aromatic volatiles, pesticides, polychlorinated biphenyls, acidic volatiles, and metals. (See W89-06633 thru W89-06636 and W89-06638) (Lantz-PTT)
W89-06637

INSTALLATION RESTORATION PROGRAM. PHASE II - CONFIRMATION/QUANTIFICATION, STAGE 1. FINAL REPORT FOR AIR FORCE PLANT 4, FORT WORTH, TEXAS. VOLUME 10. APPENDIX L.
Radian Corp., Austin, TX.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A190 449. Price codes: A14 in paper copy, A01 in microfiche. Report No. DCN 87-212-027-27-01, December 1987. 622p. USAF Contract F33615-83-D-4001. Radian Contract 212-027-27.

Descriptors: *Cleanup operations, *Data collections, *Water quality, *Groundwater quality, *Surface water, Water sampling, Water analysis, Volatile organic compounds, Organic compounds, Hydrocarbons, Pesticides, Polychlorinated biphenyls, Aromatic compounds, Metals.

This volume presents 'Appendix L' Installation Restoration Program. Phase II Confirmation/Quantification, Stage 1. Final Report for Air Force Plant 4, Fort Worth, Texas. Volume 10. It includes analytical data from past and ongoing studies performed by Hargis and Associates for General Dynamics. The groundwater quality data compiled by Hargis and Associates, and used for comparison in the IRP Phase II Study, are listed by the report from which they were obtained. Phase II investigations of subsurface conditions, U.S. Air Force Plant No. 4, Fort Worth, Texas (1985); appendices H-K and table 1; water quality data, May 1985 through May 1985, U.S. Air Force Plant No. 4, Fort Worth, Texas (1986); appendices C, D, E, and G. These data were analyzed for hydrogenated volatiles, aromatic volatiles, pesticides, polychlorinated biphenyls, acidic volatiles, and metals. (See KW89-06633 thru W89-06637) (Lantz-PTT)
W89-06638

ANNOTATED BIBLIOGRAPHY ON WELLHEAD PROTECTION PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
For primary bibliographic entry see Field 10C.
W89-06640

ROLE OF EPA'S OFFICE OF RESEARCH AND DEVELOPMENT IN THE STANDARD SETTING PROCESS FOR DRINKING WATER,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
R. M. Clark.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-132212. Price codes: A03 in paper copy, A01 in microfiche. Report No. EPA/600/D-87/341, November 1987. 14p, 7 fig.

Descriptors: *Water quality standards, *Environmental Protection Agency, *Administrative agencies, *Standards, *Regulations, *Drinking water, *Water quality control, Administration, Legislation, Public health, Monitoring, Groundwater quality, Water treatment.

The EPA's mission is to administer specific Federal legislation that is intended to control and abate adverse impacts of pollution on the human environment. In order to fulfill this mission, a research program is required which addresses fundamental informational needs common to all EPA's operating programs. Research support to the Agency is supplied by EPA's Office of Research and Development (OR and D). OR and D supports development of drinking water regulation in five areas: development of criteria documents; control technology; health effects; monitoring and methods; and groundwater. In addition to the formal management function of research (research committees) OR and D maintains informal liaison with the Office of Drinking Water through workgroups. An example of this liaison is the disinfection by-products workgroup. (Author's abstract)
W89-06641

NATIONAL SURFACE WATER SURVEY: EASTERN LAKE SURVEY (PHASE I--SYNOPTIC CHEMISTRY)--QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-06642

ENVIRONMENTAL RESEARCH SUMMARY-1987: TENNESSEE VALLEY AUTHORITY.
Tennessee Valley Authority, Knoxville.
Available from the National Technical Information Service, Springfield, VA 22161, as DE88-900014. Price codes: A04 in paper copy, A01 in microfiche. Report No. TVA/ONRED/EQS--87/1, 1987. 58p, append.

Descriptors: *Tennessee, *Administrative agencies, *Pollution control, *Water pollutio control, *Environmental policy, *Research priorities, *Environmental protection, Acid rain, Air pollution, Groundwater pollution, Reservoirs, Ecological

studies, Waste management, Water quality, Wildlife management, Forestry.

This annual report summarizes environmental research activities of the Tennessee Valley Authority, conducted during fiscal year 1986. This research is conducted to identify and resolve environmental problems associated with TVA's programs. TVA also considers the search for effective, practical means of protecting and enhancing the environment to be a vital component of its mission to develop and conserve the natural resources of the Tennessee Valley region. Most of TVA's environmental research activities are directed toward developing practical solutions within six broad categories of problems and issues related to the protection and enhancement of regional environmental quality. These six categories: (1) Acid deposition; (2) Air quality; (3) Groundwater; (4) Hazardous materials and waste management; (5) Surface water quality and reservoir ecology; and (6) Forest and wildlife management. An appendix is included to provide the name and address of the project director responsible for each project described in the six sections. (Lantz-PTT)
W89-06645

NATIONAL SURFACE WATER SURVEY. NATIONAL STREAM SURVEY PHASE I. PILOT SURVEY--SUMMARY OF QUALITY ASSURANCE DATA RESULTS,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
For primary bibliographic entry see Field 7B.
W89-06646

DEVELOPMENT OF A COMBINED QUANTITY AND QUALITY MODEL FOR OPTIMAL GROUNDWATER MANAGEMENT,
Arkansas Water Resources Research Center, Fayetteville.
For primary bibliographic entry see Field 4B.
W89-06655

ENVIRONMENTAL INFORMATION DOCUMENT: HYDROFLUORIC ACID SPILL AREA,
Du Pont de Nemours (E.I.) and Co., Aiken, SC. Savannah River Plant.
For primary bibliographic entry see Field 5B.
W89-06670

HAZARDOUS WASTE SITE REMEDIATION: THE ENGINEER'S PERSPECTIVE.
O'Brien and Gere Engineers, Inc., Syracuse, NY. Van Nostrand Reinhold, New York, 1988. 422p. Robert Bellandi, Technical Editor.

Descriptors: *Water pollution control, *Waste dumps, *Sanitary engineering, *Decontamination, *Cleanup operations, *Waste disposal, *Hazardous wastes, Management planning, Water pollution treatment, Biological treatment, Groundwater pollution, Waste treatment.

This guide provides coverage of techniques for conducting feasibility studies, determining site safety, modeling groundwater conditions, biologically treating groundwater, and removing underground storage tanks. It shows how to: design and implement each phase of the cleanup plan; apply effective remedial technologies, including secure burial cells, incineration, and chemical fixation; fix leaking underground storage tanks, a leading cause of groundwater contamination; and collect and analyze air, water, and soil data to determine the degree of the hazard. (Lantz-PTT)
W89-06677

CLEAN WATER ACT PERMIT GUIDANCE MANUAL,
Smith and Schnacke, Dayton, OH.
R. S. Frye, J. W. Blattner, J. Z. Cannon, and J. N. Hanson.
Executive Enterprises Inc., New York. April 1984. 644p.

Descriptors: *Water law, *Handbooks, *Wastewater disposal, *Permits, *National Pollutant Discharge *Clean Water Act, *Regulations, *Water pollution control, Manuals, Elimination System, Wastewater treatment.

This Manual provides background information and guidance for obtaining or renewing National Pollutant Discharge Elimination System (NPDES) permits for the direct discharge of water pollutants to surface waters. This Manual does not cover related permit programs, such as pretreatment permits for facilities which discharge wastewater to municipal sewer systems, Underground Injection Control permits for discharge of pollutants to underground wells, or Army Corps of Engineers Section 404 permits for dredging or filling activities in waters of the United States. The present NPDES permitting program is a very complex regulatory scheme which has changed greatly in the past several years and which continues to change. Many, if not most, facilities are now operating under permits that have expired or will soon expire. As EPA and the states begin to reissue the tremendous backlog of expired permits, companies will need to understand the requirements of the current rules and be aware of the favorable changes which might be available within the next few months. The first portion of the text addresses what is contained in a permit--effluent limitations and other conditions--while the latter portion addresses the procedures for obtaining, modifying, and terminating NPDES permits and explains the legal liability which you may have for a discharge even if you have an NPDES permit. (Lantz-PTT)
W89-06679

REVERSIBILITY OF ACIDIFICATION.
Elsevier, New York. 1987. 175p. Edited by H. Barth.

Descriptors: *Air pollution effects, *Water pollution sources, *Acidification, *Rehabilitation, *Model studies, *Acid rain, Sulfur, Nitrogen, Land use, Theoretical analysis.

Knowledge of the effects on aquatic ecosystems of changes in atmospheric deposition of acidifying components is reviewed. In particular, the question of whether aquatic ecosystems will recover from acidification once acidifying depositions are reduced is examined. Emphasis is given to modeling of the expected effects of reduced atmospheric sulfur and nitrogen deposition. The important role of ammonium, including gaseous ammonia emissions, as a source of acidification through nitrification was demonstrated in several investigations. Land-use changes as they relate to the effects of changes in deposition are also taken into account, but mitigation by measures such as liming was excluded. Conclusions are that (1) aquatic ecosystems will recover from acidification once acidifying deposition is reduced; (2) a return to pre-industrial precipitation composition would have benefits in improved water quality within a decade; and (3) land use practices can modify the effects of acidifying deposition. Both theoretical and experimental research results that: aquatic ecosystems will recover from acidification once acidifying deposition is reduced: a return to pre-industrial precipitation composition would have benefits in improved water quality within a decade; land use practices can modify the effects of acidifying deposition; and the important role of ammonium, including gaseous ammonia emissions, as a source of acidification. (See W89-06687 thru W89-06697) (Author's abstract)
W89-06680

RECOVERY OF CANADIAN LAKES FROM ACIDIFICATION,
Department of Fisheries and Oceans, Winnipeg (Manitoba). Freshwater Inst.
D. W. Schindler.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 2-13. 3 fig, 3 tab, 22 ref.

Descriptors: *Acid rain effects, *Water pollution effects, *Acidity, *Lake restoration, *Canada, Sulfur, Sulfates, Hydrogen ion concentration, Alkalinity, Trout, Sculpin, Fathead minnows, Crustaceans, Phytoplankton, Ontario.

The recovery of Canadian lakes from acidification was studied in the Sudbury, Ontario, area, where emissions and deposition of sulfur have decreased since the mid 1970s, and in Lake 223 of the Experimental Lakes Area (also in Ontario), which was experimentally acidified to pH 5 between 1976 and 1983. The pH values increased by 0.4 to 1.7 units, and increases in alkalinity were observed in lakes where measurements were made. The increases in alkalinity appeared to be caused by the much greater rate of decrease in sulfate than in base cations. Recoveries were equal to, or slightly slower than, those predicted from water-renewal rates. The concentrations of sulfate decreased rapidly in all lakes after sulfur inputs were reduced. In Lake 223, reproduction of all species of fishes had ceased when the lake was acidified below pH 5.4. When the pH was raised to this value during the recovery of the lake, reproduction resumed in all species which remained, with the exception of lake trout. The condition of lake trout improved when the pH was increased, but so far they have not reproduced. Animal species eliminated by acidification, including opossum shrimp, crayfish, Cottus cognatus, and fathead minnows have not returned to the lake so far. Phytoplankton diversity increased as the pH increased, and algal species eliminated by acidification returned to the lake. (See also W89-06680) (Author's abstract)
W89-06681

RAIN PROJECT: RESULTS AFTER 2 YEARS OF TREATMENT,
Norsk Inst. for Vannforskning, Oslo.
R. F. Wright.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 14-29. 7 fig, 3 tab, 13 ref.

Descriptors: *Water pollution control, *Acid rain, *Norway, *Air pollution effects, *Water pollution sources, *Experimental basins, *Water pollution treatment, *Water quality control, Soil chemistry, Snowpack, Runoff, Sulfuric acid, Runoff, Streambeds, Aluminum, Nitrates, Sulfates.

Project RAIN (Reversing Acidification in Norway) is a 5-year international research project aimed at investigating the effect on water and soil chemistry of changing acid deposition to whole catchments. The project comprises 2 parallel large-scale experimental manipulations--artificial acidification at Sogndal and exclusion of acid rain at Risdalsheia. Treatment at Sogndal commenced April 1984 with the acidification of the snowpack by addition of sulfuric acid and a 1:1 mixture of sulfuric and nitric acids. Acid addition caused rapid and dramatic increases in runoff acidity and aluminum concentrations. Most of the added acid was retained in the catchments. At Risdalsheia treatment began in June 1984 at KIM catchment (treatment by deacidified rain) and EGIL catchment (control with ambient acid rain). After 1 1/2 years of treatment about 1100 mm of clean precipitation had been applied at KIM. Nitrate was reduced by 75% and sulfate by 35% in runoff from KIM relative to EGIL. Reduction in these anions were balanced by lower levels of most cations. Aluminum concentrations in runoff at Sogndal indicated a lower solubility of labile Al in 1985 relative to 1984. Acid addition has perhaps depleted a reservoir of readily-soluble aluminum in the streambed at these catchments. (See also W89-06680) (Author's abstract)
W89-06682

ACIDITY MITIGATION IN A SMALL UPLAND LAKE,
Cambridge Univ. (England). Dept. of Applied Biology.
G. Howells.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 104-111. 1 fig, 4 tab, 9 ref.

Descriptors: *Acid rain, *Water pollution treatment, *Lakes, *Acidity, *Lake restoration, *Catchment areas, Granites, Forest watersheds, Land management, Drainage practices, Productivity, Water quality, Lime, Scotland.

Loch Fleet in Galloway, southwest Scotland, is a small (17 ha) lake receiving drainage from a 107-ha catchment lying on coarse muscovite/biotite granite. The lake is acid (generally pH 4.0 to 4.5) and is reported to have been less acid in the 1960s (pH 5.5 to 6.0). On the western shore, an area (12% of the total catchment) was afforested in 1961; the species planted were Sitka spruce and lodgepole pine, with some larch along the lakeshore. The remainder of the catchment consists of rough moorland dominated by Molinia caerulea (flying bent) or Calluna vulgaris (heather). Data on deposition, catchment characteristics, and water quality will be used to estimate the changes that are likely to result from alternative acidity-mitigation strategies. It is too early to report the later outcome of liming treatments, but present results look promising. On the other hand, the possible benefits from emission reduction or deforestation seem uncertain and insignificant for this site. Changes in land management at Loch Fleet (grazing and burning) or in hydrological management (diverting or treating forest drainage) are worth consideration, since historic records suggest that changes in management occurred over the time of water-quality decline. Other procedures may include an increase in lake productivity, and treatment of stream gravels. (See also W89-06680) (Shidler-PTT)
W89-06691

MODELLING REVERSIBILITY OF ACIDIFICATION WITH MATHEMATICAL MODELS,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
B. J. Cosby.
IN: Reversibility of Acidification. Elsevier, New York. 1987. p 114-125. 4 fig, 16 ref.

Descriptors: *Acid rain effects, *Acidic water, *Soil water, *Streams, *Rehabilitation, *Mathematical models, Hydrogen ion concentration, Alkalinity, Cations, Aluminum, Catchment areas, Water quality, Prediction, Model studies.

Quantitative predictions of the effects of reduced acid deposition (the reversibility of acidification) require physically-based process-oriented models of catchment soil-water and stream-water chemistry. The most serious effects of acid deposition are thought to be decreased pH and alkalinity and increased base-cation and aluminum concentrations. Alkalinity is generated in the soil water by the formation of bicarbonate from dissolved carbon dioxide and water. The steady-state conditions require that the alkalinity of any catchment be reduced by an amount equal to the acidity of the precipitation when a new steady state is achieved. A particular model, MAGIC, was used to examine the patterns and time scales of water-quality changes following reduced deposition. Models of acid-deposition effects, be they empirical or mechanistic, simple or complex, are all developed with the implied goal of estimating catchment responses to changes in deposition rates at some point years or decades in the future. Obviously, we are not presently in a position to conclude that our projections derived from models are correct in a quantitative sense. But, even though quantitative models of catchment response cannot be strictly verified for their ultimate use of long-term estimation, they can be used as heuristic tools to stimulate and inform the synthesis of current research results. (See also W89-06680) (Shidler-PTT)
W89-06692

CHANGES IN STREAMWATER CHEMISTRY AND FISHERY STATUS FOLLOWING REDUCED SULPHUR DEPOSITION: TENTATIVE PREDICTIONS BASED ON THE 'BIRKENES MODEL',
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 2K.
W89-06695

STATUS OF THE U.S. EPA'S SEDIMENT QUALITY CRITERIA DEVELOPMENT EFFORT,
Environmental Protection Agency, Washington, DC.
C. S. Zarba.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 13-17, 1 fig.

Descriptors: *Sediments, *Environmental Protection Agency, *Water quality standards, Pollutant identification, Administrative regulations, Policy making, Workshops, Clean Water Act.

In July, 1984, under the authority of the Clean Water Act, the EPA initiated an effort to develop sediment quality criteria. This effort was initiated with a workshop in which a variety of experts worked to identify and approach by which the Agency could develop numerical sediment quality criteria. Efforts are under way to evaluate, modify, and verify the approach selected by the workshop using literature reviews, bioassays, data analysis, and field verification studies. The near-term goal of this effort is to present the findings of the activity to the EPA's Science Advisory Board for review and eventual approval. Specific activities over the last 2 yr have covered the following: review of methodologies, national perspective using STORET, sediment criteria development workshop, theory elaboration, toxicity testing protocol, development of screening level considerations, technical steering committee meetings, preliminary field verification study, uncertainty analysis, sampling guidance, and regulatory options. Future activities will cover general regulatory considerations, nonpolar organic compounds, and metals. A flowchart of sediment quality criteria development is presented. (See also W89-06705) (Rochester-PTT)
W89-06708

DEVELOPMENT, EVALUATION, AND USE OF THE TOXICITY CHARACTERISTIC LEACHING PROCEDURES (TCLP),
Environmental Protection Agency, Washington, DC. Office of Solid Waste.
For primary bibliographic entry see Field 5A.
W89-06719

ANALYTICAL METHODS NECESSARY TO IMPLEMENT RISK-BASED CRITERIA FOR CHEMICALS IN MUNICIPAL SLUDGE,
Environmental Protection Agency, Cincinnati, OH. Environmental Criteria and Assessment Office.
For primary bibliographic entry see Field 5E.
W89-06744

REGULATION OF SLUDGE DISPOSAL THROUGH APPLICATION OF RISK ASSESSMENT TECHNIQUES,
ICF Technology, Inc., Richland, WA.
For primary bibliographic entry see Field 5E.
W89-06745

ISOMER-SPECIFIC DETERMINATION OF PCDD/PCDF IN WATER LEACHATE OF A WASTE LANDFILL,
Kernforschungszentrum Karlsruhe G.m.b.H. (Germany, F.R.).
For primary bibliographic entry see Field 5A.
W89-06754

PESTICIDF MICROPOLLUTANTS IN LAKE ALBUFERA (SPAIN),
Universidad Politecnica de Valencia (Spain). Dept. of Biotechnology.
For primary bibliographic entry see Field 5B.
W89-06755

MONITORING OF THE RIVER RHEIN - EXPERIENCE GATHERED FROM ACCIDENTAL EVENTS IN 1986,
For primary bibliographic entry see Field 5A.
W89-06768

TEST METHODS AND STRATEGIES FOR ENVIRONMENTAL MANAGEMENT PURPOSES - ENVIRONMENTAL FATE TESTING OF CHEMICALS AND EFFLUENTS,
Vandkvalitetsinstitutet, Hoersholm (Denmark).
N. Nyholm.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 256-265. 3 fig, 1 tab, 19 ref.

Descriptors: *Environmental policy, *Environmental protection, *Fate of pollutants, *Effluents, *Biodegradation, Surface water, Water analysis, Sampling, Regulatory agencies, Water management, Water policy.

A survey is presented of practical management-oriented methods and strategies for environment fate testing of chemicals and effluents with the main emphasis on inherent or potential biodegradability or treatability. The main focus of the paper is the EEC legislative tests and current international cooperative work on test development and test harmonization. It is pointed out that test methods and strategies developed for use in connection with notification and general regulation of chemicals can be used in modified form for testing of specific effluents. For examination of effluents discharged to surface water, a stepwise strategy is suggested as feasible, including screening of biodegradability using long-term BOD testing, shake flask die-away testing, and a stabilization study involving incubation of the effluent with surface water under aerobic conditions. It is suggested that if resources are available, tests on the effluent should be complemented with chemical monitoring in the near field around the discharge. (See also W89-06748) (Friedmann-PTT)
W89-06782

PLANNING AND STRATEGY OF WASTEWATER AND WASTEWATER REUSE IN JORDAN,
Water Authority of Jordan, Amman. Treatment Plants Dept.
For primary bibliographic entry see Field 3C.
W89-06819

EFFECTS ON WATER QUALITY DUE TO FLOOD-WATER DETENTION BY BARKER AND ADDICKS RESERVOIRS, HOUSTON, TEXAS,
Geological Survey, Austin, TX. Water Resources Div.
For primary bibliographic entry see Field 5B.
W89-06847

NATIONAL WATER SUMMARY 1986: HYDROLOGIC CONDITIONS AND GROUND-WATER QUALITY,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2A.
W89-06890

INTERACTIVE ENVIRONMENTAL IMPACT AND ECONOMIC ANALYSIS OF THE BENEFITS OF POTABLE GROUNDWATER ON CAPE COD,
Woods Hole Oceanographic Institution, MA.
S. F. Edwards, and A. R. Solow.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 195896/AS, price codes: A03 in paper copy, A01 in microfiche. Completion Report, 1988. 22p, 3 fig, 5 tab, 9 ref. USGS contract 14-08-0001-G1404.

Descriptors: *Environmental impact, *Economic analysis, *Cape Cod, *Groundwater pollution, *Groundwater protection, *Nitrates, Benefits, Groundwater, Potable water, Water demand, Water quality, Estimation, Regression models, Massachusetts.

The goal of this project was to estimate the economic benefits of protecting potable groundwater from nitrate contamination on Cape Cod, Massachusetts. The work consisted of three steps: (1) estimating the public's total demand for clean water, taking supply uncertainty into account; (2)

estimating the probability of future nitrate contamination using historical data; and (3) combining the results of (1) and (2) to arrive at an estimate of the overall economic benefits of groundwater protection. Demand estimation was performed by the contingent valuation method. The results of this analysis indicated a strong demand for clean water. The estimation of the probability of future contamination was based on a regression model of the relationship between nitrate level and population. This analysis indicated that the probability of future contamination is extremely small. Therefore, the economic benefits of protecting groundwater from nitrate contamination under current conditions is essentially zero. (USGS)
W89-06911

EVALUATION OF SUBSURFACE AND OUTFLOW WATER QUALITY FROM A DRAINAGE-SUBIRRIGATION SYSTEM IN THE GEORGIA FLATWOODS,
Georgia Coastal Plain Experiment Station, Tifton. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 3F.
W89-06913

CHLORINATED ORGANICS REMOVAL FROM CONTAMINATED SOIL AND GROUNDWATER BY MICROORGANISMS,
Minnesota Univ., Minneapolis. Graduate School.
C. J. Kim.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627022. Ph.D. Dissertation, 1986. 302p, 59 fig, 32 tab, 148 ref, append.

Descriptors: *Fate of pollutants, *Water pollution treatment, *Water pollution control, *Groundwater pollution, *Biodegradation, *Phenols, *Soil contamination, Water pollution prevention, Chlorination, Organic compounds, Organic wastes, Biological treatment.

Pentachlorophenol (PCP) biodegradation was measured in contaminated groundwater that contained large concentrations of other organic pollutants, in the presence of sand particles, in short sand column continuous flow tests, and in long sand column tests. The acclimated culture biodegraded PCP and other organic pollutants in contaminated groundwater at 15 C. Addition of nitrogen and phosphorous sources may be necessary if the groundwater is low in nutrient concentrations. The addition of silica sand particles into PCP culture medium enhanced PCP biodegradation significantly by reducing lag time. The removal efficiency of PCP in short sand columns operating under unsaturated flow conditions was much better than under saturated flow. Results of long column tests confirmed those of the short column tests; the biodegradability of aerobic PCP acclimated microorganisms was enhanced in unsaturated flow columns. In-situ cleanup of contaminated soil and groundwater was demonstrated by recycling the effluent from a PCP contaminated soil column into a treatment sand column, which had been inoculated. (Cremmins-AEPCO)
W89-06928

GEOTOX: A KNOWLEDGE-BASED SURROGATE CONSULTANT FOR EVALUATING WASTE DISPOSAL SITES,
Lehigh Univ., Bethlehem, PA. Graduate School.
For primary bibliographic entry see Field 5E.
W89-06929

CHARACTERIZATION OF FLUID FLOW AND WASTEWATER TRANSPORT PROCESSES WITHIN A WISCONSIN-TYPE MOUND,
Purdue Univ., Lafayette, IN.
For primary bibliographic entry see Field 5D.
W89-06937

DEVELOPMENT OF RESERVOIR OPERATING RULES WITH WATER QUALITY OBJECTIVES,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
K. B. Hogan.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8609324. Ph.D. Dissertation, 1986. 138p, 38 fig, 5 tab, 39 ref, 2 append.

Descriptors: *Decision making, *Stochastic hydrology, *Reservoir operation, *Water quality control, Model studies, Simulation analysis, Operating policies, Optimization, Streamflow forecasting.

Operating rules for the real-time operation of a reservoir were developed using water quality criteria. The methodology uses both preceding basin conditions and available historical data and consists of supporting models which represent the physical processes within the system. One procedure uses multiple simulated future sequences and for each year of historical record, which are conditional on initial basin conditions and represent the stochastic nature of hydrologic events and the associated values of water quality constituents. This procedures allows the derivation of reliabilities which accompany the sustained yields of various qualities. In a second procedure, the operating rule is applied to a limited number of stochastically generated future sequences. With each sequence, release decisions are based on the preceding conditions and how these conditions compare to a set of generated preceding conditions. Information is aggregated into an indicator of the current state of a hypothetical reservoir corresponding to each sequence. Results of comparisons between the state of the actual reservoir and the set of hypothetical reservoirs are used in daily decision making. (Cremmins-AEPCO)
W89-06942

OPTIMAL WELL LOCATION IN A MULTI-AQUIFER GROUNDWATER SYSTEM,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
S. Al-Hassan.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8619413. Ph.D. Dissertation, 1986. 186p, 16 fig, 14 tab, 46 ref, 6 append.

Descriptors: *Water quality control, *Conjunctive use, *Optimization, *Model studies, *Well water, *Computer models, *Groundwater management, Groundwater potential, Mathematical models, Simulation analysis, Pumping, Chemical degradation, Utah, Sevier-Sigurd basin.

A model was developed to optimize the location of wells in a multi-aquifer groundwater system subjected to chemical degradation. The use of the waters of the various layers of the multi-aquifer system and a surface water system was optimized by blending to achieve a desired water quality and demand at minimum cost. The optimal well locations and their pumping rates were determined for different management alternatives. The Sevier-Sigurd basin in Central Utah was used as a case study. Management studies using the lumped model indicate that it is not feasible to use the groundwater of this basin to satisfy both supplemental agricultural water requirements and river blending. For this basin, farmers should be allowed to develop their wells for supplemental irrigation demand at the point of demand. Seepage from the aquifer to the river should be reduced and river flow past Vermillion Dam should be increased to reduce the salinity of the Sevier River. (Cremmins-AEPCO)
W89-06946

SOLUBILITY, MOBILITY AND PLANT UPTAKE OF TOXIC ELEMENTS IN RETORTED OIL SHALES AS AFFECTED BY RECARBONATION,
Colorado State Univ., Fort Collins. Dept. of Agronomy.
For primary bibliographic entry see Field 5B.
W89-06953

ANALYTICAL MODEL FOR ESTABLISHING WATER RESOURCES DEVELOPMENT PRIORITIES,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 6A.
W89-06969

WATER QUALITY MANAGEMENT SIMULATION GAME,
Oklahoma State Univ., Stillwater. Graduate Coll.
S. A. Chiang.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8709694. Ph.D. Dissertation, 1986. 146p, 8 fig, 31 tab, 52 ref, 9 append.

Descriptors: *Water quality management, *Simulation analysis, *Water quality standards, *Water permits, Flow discharge, Waste load, Discharge capacity, Computer models, Computer programs, Cost analysis.

A management simulation game was developed to explore the effectiveness of achieving water quality standards with a system of transferable discharge permits (TDP). The potential for substantial cost savings from trading TDP's was demonstrated using data on a hypothetical river. A simulation model of water quality (QL2SMG) was used to study the impact of waste loads on in-stream water quality. QL2SMG permits simulation of oxygen dynamics in a one-dimensional system with steady state hydraulics. Findings indicate TDP distribution should be considered in terms of both the permitted standards and discharge capacity. Priority rights can increase the adaptability of the TDP system to short-term fluctuations in the assimilative capacity of the environment. The definition base of permits should include not only biological oxygen demand and dissolved oxygen, but also nitrogen, phosphate, and heavy metals. Unrestricted transfers of BOD permits could cause violations of water quality standards. Restricting transfers of permits to geographical zones could reduce or possibly prevent violations of a standard. (Cremmins-AEPCO)
W89-06971

6. WATER RESOURCES PLANNING

6A. Techniques Of Planning

OPERATIONAL GUIDANCE DURING DROUGHTS: EXPERT SYSTEM APPROACH,
Washington Univ., Seattle. Dept. of Civil Engineering.
R. N. Palmer, and K. J. Holmes.
Journal of Water Resources Planning and Management JWRMD5, Vol. 114, No. 6, p 647-666, November 1988. 9 fig, 24 ref, append.

Descriptors: *Operating policies, *Droughts, *Computer programs, *Drought management, *Decision making, *Expert systems, *Management planning, Water management, Water supply, Water policy, Mathematical studies, Washington, Water demand, Prediction, Forecasting, Mathematical models.

Seattle, Washington, suffered its most extreme drought on record during the summer and fall of 1987. Severe and continuing water use restrictions were required to limit the drought's impact on municipal water supplies, fish populations, and navigation. This paper describes a decision support system used to aid in drought decisions. Its components include an expert system, a linear programming model, database management tools, and computer graphics. The expert system incorporates operator experience and intuition using a rule base developed through interviews with management personnel from the Seattle Water Department. The expert system also integrates the other programming techniques into a single system. A linear programming model determines system yield and optimal operating policies for past hydrologic regimes. Database management and graphics software store and allow the display of over two thousand operating policies to decision-makers.

The system provides user-friendly support to help decision-makers explore a wide range of management alternatives. (Author's abstract)
W89-05819

INFLUENCE OF DIFFERENT DOWNSTREAM USERS ON SINGLE MULTIPURPOSE RESERVOIR OPERATION BY CHANCE CONSTRAINTS,
Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W89-05826

SITE DESIGN FOR RESOURCE RECOVERY FACILITIES,
Burns and Roe, Inc., Oradell, NJ.
For primary bibliographic entry see Field 5E.
W89-05953

ON-FARM APPLICATION SYSTEM DESIGN AND PROJECT-SCALE WATER MANAGEMENT,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W89-05960

ALLOCATION OF INCREMENTAL IRRIGATION BENEFITS,
Water Conservancy Hydroelectric Power Scientific Research Inst., Beijing (China).
For primary bibliographic entry see Field 3F.
W89-05962

HYDROPOWER PROJECT DESIGN INCORPORATING SUBMERGENCE COSTS,
Indian Inst. of Science, Bangalore. Dept. of Computer Science and Automation.
For primary bibliographic entry see Field 8A.
W89-06006

MULTIOBJECTIVE, DISCRETE SYSTEM REPRESENTATION OF RANGELAND WATERSHEDS,
Maricopa County Flood Control District, Phoenix, AZ.
D. Khalili, L. Duckstein, and M. M. Fogel.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1035-1040, October 1988. 2 fig, 4 tab, 16 ref.

Descriptors: *Desertification, *Decision making, *Watershed management, *Administrative decisions, *Range management, Evaluation, Model studies, Simulation.

Resource utilization is identified as the main cause of the degradation of rangeland watersheds, a process referred to as desertification. A multiobjective decision making methodology is outlined for the selection of a plan which if implemented, should limit the desertification process. The evaluation objectives are measured by quantitative and qualitative criteria. The quantitative criteria provide the performance level for production and sediment yield, while the qualitative criteria give such information as public acceptance of a particular alternative or worth of an appropriate wildlife habitat. A system model is applied to describe the dynamics of a range site in response to climatic and human inputs. As such it provides the information required by the quantitative criteria as well as a range condition index that identifies the productivity of a given range site. A multiobjective selection procedure is presented that will lead to the appropriate technique from an available set, in this case ESAP, Environmental Sensitivity Analysis Package. Four individuals with diverse backgrounds in natural resource management participated as decision makers and decided on their preferred alternatives. Finally, ranked alternatives in agreement with all of the decision makers were obtained. (Author's abstract)
W89-06059

MODELING INSTREAM RECREATIONAL BENEFITS,
Colorado State Univ., Fort Collins.
M. Flug, and R. H. Montgomery.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1073-1081, October 1988. 8 fig, 2 tab, 21 ref.

Descriptors: *Water use, *Recreation demand, *River flow, *Nonconsumptive use, *Water management, *Decision making, *Multiobjective planning, Model studies, Flow pattern, West Virginia.

A basic problem in the management of rivers has been how to balance the tradeoffs between instream and out-of-stream uses. Traditionally, the problem has been addressed by optimizing the economic benefits of flow diversions and regulated releases with instream uses as a flow constraint. An alternative method is to model the effect different river flows have on various recreational uses (e.g., boating, fishing) and then use the results as an additional function or piece of information to determine river project operations and benefits. A methodology that is based on multiobjective decision theory and that relates instream recreational preferences to river flow consists of determining, standardizing, and combining recreational benefit functions, and incorporating potential sources of uncertainty into an estimate of total instream benefits. Thus different types of flow patterns, resulting from reservoir regulation (out-of-stream water uses), can be analyzed to determine their potential instream impact. The methodology is applied to the New River Gorge, West Virginia, which has been designated as a National River. Two management options were compared: (1) maintaining the river as is (present average flow regime) or (2) increasing out-of-stream uses and decreasing the present average flow (low flow regime). The incorporation of uncertainty in the analysis showed that while there were differences in the estimated monthly and annual mean benefits, there is a chance that no difference in the amount of benefits may occur. (Vernooy-PTT)
W89-06064

DISJUNCTIVE KRIGING AS AN APPROACH TO MANAGEMENT DECISION MAKING,
Agricultural Research Service, Riverside, CA. Salinity Lab.
S. R. Yates, and M.V. Yates.
Soil Science Society of America Journal SSSJD4, Vol. 52, No. 6, p 1554-1558, November-December 1988. 5 fig, 1 tab, 21 ref. EPA Interagency Agreement DW 129326310-01-0.

Descriptors: *Water pollution prevention, *Management planning, *Viruses, *Probability distribution, *Septic tanks, *Kriging, Tucson, Arizona, Municipal Water, Wells, Hydraulic gradient, Contamination, Groundwater pollution.

Disjunctive kriging is a nonlinear estimation technique that allows the conditional probability that the value of a spatially variable management parameter is greater than a cutoff level to be calculated. The method can be used in management decision making to help determine when some reclamation action is necessary. Two input parameters are required to use the technique: a cutoff level and the critical probability level. The use of disjunctive kriging as a decision making tool is illustrated using the regulation of septic tank setback distance as a means for minimizing the contamination of groundwater by viruses. Water samples were collected from 71 municipal drinking water wells in the Tucson Basin and were used in the determination of the virus inactivation rates. Viruses were added to the water samples, which were incubated at the in situ groundwater temperature. Periodically, subsamples were analyzed to determine the number of viruses remaining in the water samples. The virus inactivation rates were calculated based on these analyses. Hydraulic gradients were calculated from a water table elevation map obtained from the city of Tucson. Two examples are described: given a setback distance, the spatial distribution of the conditional probability that the virus concentration will be greater than acceptable levels is calculated; and given a critical probability level, calculating the spatial distribution of setback distances which satisfy that probability level. The study showed that, to be 90% confident that virus concentrations would be within acceptable limits, in many areas, the setback distance would have to be severalfold higher than prescribed by current regulations. (Author's abstract)
W89-06073

'ECOSYSTEM' APPROACH TO MANAGING HUMAN USES AND ABUSES OF NATURAL RESOURCES IN THE GREAT LAKES BASIN,
Department of Fisheries and Oceans, Burlington (Ontario). Great Lakes Lab. for Fisheries and Aquatic Sciences.
J. R. Vallentyne, and A. M. Beeton.
Environmental Conservation EVCNA4, Vol. 15, No. 1, p 58-62, 1988. 1 fig, 37 ref.

Descriptors: *Water quality management, *Great Lakes, *Management planning, *Ecosystems, *Resources management, Water resources development, Interagency cooperation, Governmental interrelations.

An approach to planning, research, and management, that relates people to ecosystems of which they are part, is described and related to the Canada-United States Great Lakes Water Quality agreements of 1972, 1978, and 1987. Factors favoring the development of an ecosystem approach in the Great Lakes Basin include: a shared, highly valued resource; the long residence-times of conservative pollutants in the Lakes; use of the lakes for drinking-water supplies by about 23 million people; threats to the integrity of the Lakes (pollution, water diversion); advances in ecosystem theory; the rise of voluntary membership associations with interests in the resource; institutional arrangements for managing nationally shared resources; and common economic ties and cultural heritages. The principal obstacle to implementation of an ecosystem approach in the Great Lakes basin is the lack of policies for comparable approaches in the political jurisdictions surrounding the Great Lakes. The principal obstacle to global implementation of an ecosystem approach is the lack of international institutional arrangements for joint advice and operational capabilities in respect to the management of nationally shared resources. Another impediment is the widespread egocentricity of governments, corporations, individuals, and the general public. (Author's abstract)
W89-06159

IMPORTANCE OF THE NEARSHORE AREA FOR SUSTAINABLE REDEVELOPMENT IN THE GREAT LAKES WITH OBSERVATIONS ON THE BALTIC SEA,
Wisconsin Univ.-Green Bay. Inst. for Land and Water Studies.
H. J. Harris, V. A. Harris, H. A. Regier, and D. J. Rapport.
Ambio AMBOCX, Vol. 17, No. 2, p 112-120, 1988. 6 fig, 54 ref.

Descriptors: *Great Lakes, *Water resources development, *Baltic Sea, *Project planning, *Lake restoration, Management planning, Vegetation, Phosphorus, Nutrient removal, Nearshore processes, Wetlands, Marsh management.

The ecological systems of the nearshore waters and wetlands play similar ecosystemic roles in the Baltic and Great Lakes Basins. A major difference in the more detailed features relates to the phytal dominated by Fucus spp (bladderwrack) in the more saline parts of the Baltic; the attached algae community in the Great Lakes that is broadly comparable to the Baltic's phytal is relatively less important, or so it seems now. Nearshore waters and wetlands are the loci for key self-organization processes within large aquatic ecosystems. They provide locales and resources for critical reproductive and feeding periods of large organisms (fish, shellfish, mammals, birds) that dominate and regulate other species in the aquatic realm. They tend to modulate sharp influences such as nutrient pulses and floods. The nearshore waters of the Baltic and Great Lakes have all been degraded in part, but especially those near industrialized urban centers. Efforts toward rehabilitation of such ecological slums and toward preservation of relatively pristine heritage areas are now getting underway,

if only slowly. Postindustrial societies are coming to value nearshore waters and wetlands far more than previous societies. (Author's abstract)
W89-06164

ENERGY ANALYSIS APPROACH TO ECOSYSTEM REDEVELOPMENT IN THE BALTIC SEA AND GREAT LAKES,
Askoe Lab., Stockholm (Sweden).
A. M. Jansson, and B. O. Jansson.
Ambio AMBOCX, Vol. 17, No. 2, p 131-136, 1988. 4 fig, 2 tab, 34 ref.

Descriptors: *Fish management, *Ecosystems, *Great Lakes, *Baltic Sea, *Lake restoration, *Fisheries, Solar energy, Trophic level, Salmon, Hydroelectric power, Dams, Electric power production, Energy transfer.

The environmental degradation of large lakes and coastal seas shows similar disturbance patterns which calls for a common approach to redevelopment. Energy analysis is proposed as a tool to understand and quantify processes in ecological and economic systems and their interrelationships. It facilitates the design of management strategies that with moderate expenditures of energy and capital for the human society takes greatest possible advantage of Nature's own capacity for rehabilitation. The basic principle is that energy during its flow through the systems network is successively upgraded in quality by various processes and that the 'emergy', the embodied energy of different parts expressed in solar energy units, quantifies the work spent to produce and maintain them. As an example the eco-redevelopment of the Baltic salmon fishery, affected by the construction of hydroelectric dams in the river systems, is compared with the Great Lakes fishery, affected by the opening of the Erie-Welland canals. Emergy calculations are demonstrated in comparison of the fish yields of the Baltic Proper and Lake Michigan. The total fixation of insolated solar energy is 0.175% and 0.125%, respectively, and the areal commercial fish yield 10 times higher in the Baltic Proper, suggesting that Lake Michigan is the more severely degraded system. A total energy analysis will give a more complete evaluation of the sustainability of the two systems. (Author's abstract)
W89-06167

HEAVY METALS AND OTHER NON-OIL POLLUTANTS IN SOUTHEAST ASIA,
Chulalongkorn Univ., Bangkok (Thailand). Dept. of Marine Science.
For primary bibliographic entry see Field 5A.
W89-06169

LIVING ON AN OIL HIGHWAY,
PERTAMINA, Djakarta (Indonesia).
For primary bibliographic entry see Field 5B.
W89-06171

TRIBAL WATER MANAGEMENT HANDBOOK.
American Indian Resources Inst., Oakland, CA.
For primary bibliographic entry see Field 6E.
W89-06628

NONLINEAR APPROACH TO THE DETERMINATION OF RESERVOIR OPERATING RULES,
Purdue Univ., Lafayette, IN. Dept. of Civil Engineering.
R. R. Cantiller.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8622127. Ph.D. Dissertation, 1986. 178p, 29 fig, 37 tab, 119 ref, 5 append.

Descriptors: *Reservoir operation, *Nonlinear programming, *Computer models, *Optimization, Systems analysis, Model studies, Simulation analysis, Water resources development, Synthetic hydrology, Mathematical models, Economic factors, Stochastic hydrology.

Two ways of incorporating a reservoir operating rule within optimization were developed: either the rule is included as an equality constraint (nonlinear programming formulation) or it is included as bounded constraints. In the latter case, the bounds may be varied systematically such that the deviation of the operating release from the target release becomes smaller with each iteration. The methodology is a modification of the implicitly stochastic optimization approach. Three previously reported approaches were solved with optimization accomplished by a common nonlinear programming algorithm. Implicitly stochastic optimization gave relatively good results for determining operating rules. Finding operation rules that perform better is possible because of developments in synthetic hydrology, mathematical programming, economic analysis, and computer technology. Testing of different operating rules and objective functions could be accomplished extensively without incurring unreasonably high demand on computer time or resources. (Cremmins-AEPCO)
W89-06924

HEURISTIC APPROACH TO THE ANALYSIS OF A CONJUNCTIVE WATER SUPPLY SYSTEM,
Oklahoma Univ., Norman. Dept. of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 5F.
W89-06930

INSTITUTIONAL AND ECONOMIC ANALYSIS OF RURAL WATER SUPPLY INFRASTRUCTURE DETERIORATION IN NEW YORK STATE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics.
C. V. Rossi.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8607240. Ph.D. Dissertation, 1986. 403p, 14 fig, 63 tab, 209 ref, 5 append.

Descriptors: *Policy making, *Rural areas, *Water supply development, *Water conveyance, Public policy, Capital, Economic aspects, Maintenance costs, Cost analysis, Financing, Regulations.

The factors which influence operation, maintenance, expenditure, and capital investment policies for rural water systems were studied to evaluate policy alternatives. Infrastructure decision making was examined and the engineering and operational effects of maintenance procedures were identified to evaluate maintenance strategy based on system condition and financing over time. Deferred maintenance and underinvestment in capital structures are not desirable policy strategies at the local level because they result in poor system conditions at higher long-term cost than regular maintenance and rehabilitation options. Public policies should be devised to implement programs of continuous maintenance and capital investment in rural water systems. A combination of financial and regulatory programs is needed to ensure that rural systems perform early maintenance to circumvent future deficiencies in plant and equipment. (Cremmins-AEPCO)
W89-06936

DEVELOPMENT OF RESERVOIR OPERATING RULES WITH WATER QUALITY OBJECTIVES,
Johns Hopkins Univ., Baltimore, MD. Dept. of Geography and Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-06942

OPTIMIZATION AND SIMULATION METHODOLOGY FOR IRRIGATION PLANNING,
California Univ., Davis.
For primary bibliographic entry see Field 3F.
W89-06945

SUSTAINED-YIELD GROUNDWATER BASIN MANAGEMENT: A GOAL-PROGRAMMING APPROACH,
Arkansas Univ., Fayetteville.
For primary bibliographic entry see Field 4B.
W89-06958

DEMAND FOR WATER RESOURCES INFORMATION: A CONCEPTUAL FRAMEWORK AND EMPIRICAL INVESTIGATION,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
C. T. Osborn.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8624345. Ph.D. Dissertation, 1986. 367p, 6 fig, 11 tab, 93 ref, 5 append.

Descriptors: *Information systems, *Water resources development, *River basin development, *Model studies, *Decision making, Federal jurisdiction, State jurisdiction, Management planning, Value, Surveys, Data processing, Data interpretation.

Empirical models were developed to evaluate demand for water resources information by federal and state decision makers involved in river basin management in two case study areas. The models were evaluated based on the relationship between characteristics of decision makers and the organization in which they work, and the types of information they demand for water resources management. A contingent valuation analysis was used to estimate the monetary value of selected items of water resources information. The practicality was assessed of the contingent ranking technique for the design of public water data systems using integer programming. Results indicate that previous use of specific water information products and the level of expenditures made on certain types of water information are influenced by personal and organizational characteristics. Thus, no 'correct' information system exists, nor is there a 'correct' data collection plan without knowledge concerning information value. Contingent ranking procedures involving items of information may be conducted in a mail survey format and the information value estimates derived through this technique can be used to promote greater efficiency in water data investment. (Cremmins-AEPCO)
W89-06964

COMPUTER DECISION SUPPORT FOR WATER SUPPLY DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W89-06968

ANALYTICAL MODEL FOR ESTABLISHING WATER RESOURCES DEVELOPMENT PRIORITIES,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
G. P. Chou.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8617408. Ph.D. Dissertation, 1986. 273p, 55 fig, 36 tab, 104 ref, 4 append.

Descriptors: *Water resources development, *Decision making, *Priorities, *State jurisdiction, *Project planning, *Model studies, Surveys, Water treatment, Water storage, Pumping, Water distribution.

An analytical priority model was developed for water resources development projects to assist state decision makers in establishing priorities, particularly among reservoir and channelization, water treatment facility, and water storage, pumping, and distribution system projects. Three scoring models were constructed, incorporating 18 evaluating factors through a single and double index approach. The factors recognize demand and deficiencies, health concerns, environmental impacts, continuity considerations, socioeconomic consequences, and local political reactions. The three basic elements of the study goal, unbiasedness, comprehensiveness, and consistency, are essentially satisfied by the model. Unbiasedness is achieved by 20 utility graphs and 45 utility equations based on factual assessments. The relative

weight of each factor is supported by three sets of Delphi survey results based on four rounds of surveys with the assistance of 133 panel experts. The model has the ability to evaluate projects with only fragmented or incomplete information. Evaluation factors that are pertinent, but for which there is no available information, are treated as if they are inappropriate and are given utility values of zero. As additional information becomes available, the projects may be reevaluated based on the new data. (Cremmins-AEPCO)
W89-06969

WATER QUALITY MANAGEMENT SIMULATION GAME,
Oklahoma State Univ., Stillwater. Graduate Coll.
For primary bibliographic entry see Field 5G.
W89-06971

DECISION METHODOLOGY FOR THE RESOURCE UTILIZATION OF RANGELAND WATERSHEDS,
Arizona Univ., Tucson. School of Renewable Natural Resources.
For primary bibliographic entry see Field 6B.
W89-06973

6B. Evaluation Process

STRATEGIES FOR COASTAL WATER QUALITY MANAGEMENT: A CASE STUDY OF LAEM CHABANG (THAILAND) DEEP-SEA PORT DEVELOPMENT,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
For primary bibliographic entry see Field 5G.
W89-06037

WATER RESOURCES POLICY: OLD MODELS AND NEW REALITIES,
Arizona Water Resources Research Center, Tucson.
For primary bibliographic entry see Field 6E.
W89-06061

FRAMEWORK FOR TECHNOLOGICAL CHOICE (A TECHNOLOGY ASSESSMENT: METHODOLOGY FOR THE CHOICE OF WASTEWATER TREATMENT FACILITIES),
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
For primary bibliographic entry see Field 5D.
W89-06402

SELECTION OF HAZARDOUS WASTE DISPOSAL ALTERNATIVE USING MULTI-ATTRIBUTE UTILITY THEORY AND FUZZY SET ANALYSIS,
Pennsylvania Univ., Philadelphia. Dept. of Systems Engineering.
For primary bibliographic entry see Field 5E.
W89-06403

WATER PLANNING: UNTAPPED OPPORTUNITY FOR THE WESTERN STATES,
Colorado Univ. at Boulder. School of Law.
D. H. Getches.
Journal of Energy Law and Policy JELPET, Vol. 9, No. 1, p 1-45, 1988. 1 fig, 161 ref.

Descriptors: *Water policy, *Regional planning, *Management planning, *Water management, Planning, Comprehensive planning, State jurisdiction, Allocation, Regional planning, Legal review, Land use, Water use.

The western states face shifting and increasing resource demands that dictate, now more than ever, the implementation of workable, comprehensive state water planning. This article explores the objectives, advantages, and fundamentals of water planning. After reviewing past, largely unsuccessful attempts at water planning, and some promising recent efforts by California and Kansas, the article suggests methods of attaining and applying a successful planning process. Fulfillment of a variety of state goals is hampered by artificially isolating water allocation and management as a system of private rights subject occasionally to public controls or largess. Comprehensive water planning deals with more than water; it integrates state goals and policies that are necessarily related to water. Water planning cannot be divorced from local land use decisions, urban growth policies, rural community problems, water quality goals, recreational needs, economic policy, environmental preservation, agricultural production, intergovernmental relations, and a panoply of other issues. The benefits of planning begin with achieving greater certainty and more productive use of water, goals that the West and its water laws and institutions have always pursued. (VerNooy-PTT)
W89-06598

INTERDISCIPLINARY APPROACH TO VALUATION OF MICHIGAN COASTAL WETLANDS,
Michigan Univ., Ann Arbor. School of Natural Resources.
G. S. Amacher, R. J. Brazee, J. W. Bulkley, and R. A. Moll.
Available from National Technical Information Service, Springfield, VA 22161 as PB89 102222/AS, Price codes: A06 in paper copy, A01 in microfiche. Michigan Institute of Water Research, E. Lansing. Technical Report No. G1429-02, April 1988. 101p, 26 fig, 8 tab, 45 ref. append. USGS contract 14-08-0001-G1429. USGS project G1429-02.

Descriptors: *Wetlands, *Wetland functions, *Economic valuation, *Coastal wetlands, *Michigan coastal wetlands, *Ecological distribution, *Multipurpose wetlands, Energy analysis, Cost analysis, Property values, Great Lakes.

Coastal wetlands are historically noted for exhibiting multiple functions and ecological diversity. The economic importance of coastal wetlands has not been extensively studied. There is a need to apply proper economic methods to value wetlands because of the continuing loss of these wetlands. Previous Michigan coastal wetland studies have not utilized accurate economic values. This study establishes three requirements to produce accurate robust value information. These requirements include a valuation method that incorporates both ecology and economics, the valuation method should be applicable to different regions and sites, and the valuation method needs to be able to address multiple sites simultaneously. This paper links together important wetland functions and economic valuation methods. Wetland functions fit one of the six market and nonmarket valuation methods. These methods are the environmental quality as input, implicit price hedonics, energy analysis, contingent valuation, travel cost, and property hedonics. Reference is made to applying these techniques for the purpose of valuing the biological and economic functions of Michigan's coastal wetlands. Complete data for use with any of the six methods is not available. Recommendations are provided for future work to refine and apply these techniques to Michigan's Coastal Wetlands. (MI St. U., IWR)
W89-06879

PROCEEDINGS, EIGHTEENTH MISSISSIPPI WATER RESOURCES CONFERENCE, 1988.
Mississippi State Univ., Mississippi State. Water Resources Research Inst.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 244777/AS, price codes: A06 in paper copy, A01 in microfiche. (1988). 93p. Edited by E. J. Hawkins. USGS contract 14-08-0001-G1431.

Descriptors: *Mississippi, *Water management, *Data storage and retrieval, *Water law, *Computer models, Mathematical models, Model studies, Groundwater movement, Surface water, Environmental impact, Waterways, Irrigation, Water treatment, Wastewater treatment, Flooding.

The proceedings of the eighteenth Mississippi water resources conference are compiled. In this conference, papers focused on specific problems, systems, and methods applicable to water management in the state and the region. Twenty-nine papers by separate authors addressed information/data management, water and wastewater treatment, surface and groundwater modeling techniques, water quality, environmental impacts, and legal/institutional issues of water management. (Hawkins-MI St U.)
W89-06899

INTERACTIVE ENVIRONMENTAL IMPACT AND ECONOMIC ANALYSIS OF THE BENEFITS OF POTABLE GROUNDWATER ON CAPE COD,
Woods Hole Oceanographic Institution, MA.
For primary bibliographic entry see Field 5G.
W89-06911

WATER RESOURCES AND RURAL GROWTH: A POLICY ANALYSIS OF WATER RESOURCE MANAGEMENT IN THE SIERRA NEVADA FOOTHILLS,
California Univ., Santa Barbara.
D. N. Birch.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. Ph.D. Dissertation, 1986. 570p, 9 tab, 105 ref, append.

Descriptors: *Water resources development, *Population dynamics, *Management planning, *Policy making, Political aspects, Water management, Land use, Water quality, Wastewater treatment, California, Sierra-Nevada foothills.

Water management policies were studied pertaining to four counties in the Sierra-Nevada region of California that have experienced population growth through reverse migration. Among hypotheses that were examined were those that infer that political cooperation between elected local representatives and nonelected land use planning and water management experts is required for the adoption of optimal resource management policy and that success of that policy depends upon a political and institutional environment receptive to its implementation. Political cooperation between elected local representatives and nonelected land use planning and water management experts is dependent upon a shared ideology that recognizes the importance of such policy. A political and institutional environment receptive to water management policy encourages the recruitment of officials that believe in its necessity. When a political and institutional environment receptive to water resource management is absent, individual actors, such as county supervisors, planning directors, environmental health directors, and members of the planning department, can achieve limited gains in the implementation of water management policy. (Cremmins-AEPCO)
W89-06970

DECISION METHODOLOGY FOR THE RESOURCE UTILIZATION OF RANGELAND WATERSHEDS,
Arizona Univ., Tucson. School of Renewable Natural Resources.
D. Khalili.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8708562. Ph.D. Dissertation, 1986. 174p, 24 fig, 25 tab, 91 ref, 6 append.

Descriptors: *Management planning, *Decision making, *Water resources management, *Model studies, *Range management, Grazing, Computer programs, Simulation analysis, Climatic data, Watershed management, Wildlife management, Recreation, Stochastic hydrology.

A decision methodology was developed for the evaluation of alternative management plans for rangeland watersheds based on climatic behavior and resource availability. A computer simulation package SCALER (Simulating Climatic and Land Effects of Ranges) was also developed. A hydrological component of SCALER particularly provid-

ed for stochastic rainfall events, shortwave solar radiation, and stochastic temperature and soil water data to estimate biomass production for perennial and annual grasses as a function of photosynthesis and respiration. The results of SCALER were used to evaluate six alternative actions: grazing system after reseeding, development as a wildlife refuge, development for recreation, and a no action alternative. A decision-making model, Evaluation and Sensitivity Analysis Program (ESAP), was adapted to evaluate alternative actions. The more knowledge that is gained in all aspects of the decision process, the better the quality of the decision, which reduces the possibility of desertification. (Cremmins-AEPCO)
W89-06973

6C. Cost Allocation, Cost Sharing, Pricing/Repayment

WELFARE IMPLICATIONS OF TUBEWELL IRRIGATION IN BANGLADESH,
Colorado State Univ., Fort Collins. Dept. of Agricultural and Natural Resource Economics.
A. U. Ahmed, and R. K. Sampath.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1057-1063, October 1988. 1 fig, 23 ref.

Descriptors: *Bangladesh, *Economic efficiency, *Irrigation wells, *Tubewell irrigation, *Economic evaluation, Monopoly, Regression analysis, Irrigation water, Shallow wells.

The economic efficiency of the water market system that is served by tubewell irrigation in Bangladesh was investigated. An attempt has been made to evaluate the efficacy of the landless irrigation groups. Using cross-sectional data and regression analysis, cost and demand functions for irrigation water were estimated. The study demonstrates the relatively superior performance of the landless groups in terms of economic efficiency in shallow tubewell irrigation operation, in comparison to irrigation operation by the landowners. (Author's abstract)
W89-06062

ECONOMICAL SAFEGUARDING OF WATER SUPPLY: THE WATER PRICE,
Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.).
For primary bibliographic entry see Field 5F.
W89-06234

PROCEDURE FOR ESTIMATING THE CAPITAL COST OF ONTARIO WASTEWATER TREATMENT PLANT USING CAPDET,
McMaster Univ., Hamilton (Ontario). Dept. of Chemical Engineering.
For primary bibliographic entry see Field 5D.
W89-06243

MULTICRITERION ANALYSIS IN TECHNICAL-ECONOMIC CALCULATIONS OF HYDROPOWER AND WATER-MANAGEMENT FACILITIES,
D. S. Shchavelev, and M. P. Fedorov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 85-87, August 1988. 1 tab, 4 fig, 6 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 17-21, February 1988.

Descriptors: *Powerplants, *Hydroelectric plants, *Costs, *Economic aspects, Cost analysis, Cost sharing, Cost-benefit analysis, Multicriterion analysis, Electric power costs, USSR.

The introduction of self-supporting and self-financing in the hydropower industry and water management requires improved methods of substantiating hydropower and multipurpose water-management facilities. The widely used method of minimum dynamic discounted costs should be supplemented by the more general method of multicriterion (multigoal) optimization. A differentiated approach is needed for an economic evaluation of electric energy and power, which is generated according to a variable load curve in conformity with the planned regime or in a regime of prompt regulation of random loads. Performance of these functions by hydrostations and pumped-storage stations requires the creation of highly maneuverable equipment with an increased operating life in start-stop and transient regimes. The creation of such equipment is related to a substantial increase of expenditures to increase its reliability. An economic effect from its introduction can be achieved only by introducing a differentiated calculation with consideration of the functional characteristics of the power stations in the power system. (White-Reimer-PTT)
W89-06266

COST EFFECTIVENESS OF THE U.S. GEOLOGICAL SURVEY STREAM-GAGING PROGRAM IN ALABAMA,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
H. H. Jeffcoat.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4336, 1987. 96p, 27 fig, 18 tab, 19 ref.

Descriptors: *Alabama, Network design, *Stream gages, *Cost analysis, *Project planning, Budgets, Statistical analysis, Streamflow, Measuring instruments, Data collection.

A study of the cost effectiveness of the stream gaging program in Alabama identified data uses and funding sources for 72 surface water stations (including dam stations, slope stations, and continuous-velocity stations) operated by the U.S. Geological Survey in Alabama with a budget of $393,600. Of these, 58 gaging stations were used in all phases of the analysis at a funding level of $328,380. For the current policy of operation of the 58-station program, the average standard error of estimation of instantaneous discharge is 29.3%. This overall level of accuracy can be maintained with a budget of $319,800 by optimizing routes and implementing some policy changes. The maximum budget considered in the analysis was $361,200, which gave an average standard error of estimation of 20.6%. The minimum budget considered was $299,360, with an average standard error of estimation of 36.5%. The study indicates that a major source of error in the stream gaging records is lost or missing data that are the result of streamside equipment failure. If perfect equipment were available, the standard error in estimating instantaneous discharge under the current program and budget could be reduced to 18.6%. This can also be interpreted to mean that the streamflow data records have a standard error of this magnitude during times when the equipment is operating properly. (Author's abstract)
W89-06836

EVALUATION OF THE COST EFFECTIVENESS OF THE 1983 STREAM-GAGING PROGRAM IN KANSAS,
Geological Survey, Lawrence, KS. Water Resources Div.
K. D. Medina, and C. O. Geiger.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4107, 1984. 57p, 6 fig, 5 tab, 16 ref.

Descriptors: *Water resources data, *Cost-benefit analysis, *Kansas, *Stream gages, *Data acquisition, Costs, Economic aspects, Budgets, Streamflow, Evaluation.

Data uses and funding sources were identified for the 140 complete record, streamflow-gaging stations operated in Kansas during 1983 with a budget of $793,780. As a result of the evaluation of the needs and uses of data from, it was found that all 140 gaging stations were needed to meet these data requirements. The average standard error of estimate for records of instantaneous discharge was 21%, assuming the 1983 budget and operating schedule of 6-week interval visitations (based on 85 of the 140 stations). It was shown that this overall degree of accuracy could be improved to 19% by altering the 1983 schedule of station visitations. A minimum budget of $760,000, with a corresponding average standard error of estimate of 25%, is required to operate the 1983 program; a budget of less than this would not permit proper service and maintenance of the stations or adequate definition of stage discharge relations. The maximum budget analyzed was $1,191,000, which resulted in an average standard error of estimate of 9%. None of the stations investigated were suitable for the application of alternative methods for simulating discharge records. Improved instrumentation can have a very positive impact on streamflow uncertainties by decreasing the amount of record lost. (Author's abstract)
W89-06859

EFFECT OF CONSERVATION PROGRAMS ON THE QUALITY OF URBAN LAWNS,
Colorado Univ. at Boulder. Dept. of Civil, Environmental, and Architectural Engineering.
For primary bibliographic entry see Field 3D.
W89-06905

APPLICATION OF ZONAL PRICING TO A METROPOLITAN WATER UTILITY,
North Carolina Univ., Chapel Hill. Dept. of Environmental Sciences and Engineering.
D. L. Schlenger.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106. Order No. 8711162. Ph. D. Dissertation, 1986, 248p, 20 fig, 20 tab, 104 ref, append.

Descriptors: *Model studies, *Mathematical models, *Water supply, *Utilities, *Pricing, *Cost analysis, Water conveyance, Economic aspects, Optimization, Municipal water, Economic efficiency, Prices, Numerical analysis, Case studies, New Jersey, Hackensack.

A mathematical model for zonal pricing by water utilities, which was developed based on spatial differences in the cost of service, was solved for optimal zonal prices and applied to a case study of a large metropolitan water utility. The model was also assessed in terms of its ability to contribute to effective rate design. The mathematical or optimization model for spatially-differentiated pricing is based on cost differences between pumping districts. The model accommodates nonlinear demand functions and incorporates nonlinear operating cost functions instead of linear functions with capacity constraints. Solution of the model as applied to the Hackensack Water Company resulted in significant increases in economic efficiency. But constraints on revenue sufficiency and the allocation of the burden of unaccounted for water had greater impacts on prices than imposing zonal pricing. Solving the model with a 25% spatial price difference constraint between prices for the high and low districts yielded reasonable rates and moderate increases in economic efficiency. Transfers of income between customers were significant partly owing to inverse elasticity pricing resulting from the revenue constraint. (Cremmins-AEPCO)
W89-06917

THREE-DIMENSIONAL OPTIMIZATIONAL MODEL OF REGIONAL WASTEWATER TREATMENT PLANT SYSTEMS WITH APPLICATION TO THE UPPER PASSAIC RIVER,
Rutgers - The State Univ., New Brunswick, NJ. Graduate Program in Environmental Science.
For primary bibliographic entry see Field 5D.
W89-06921

ALLOCATION OF GROUNDWATER RIGHTS ON THE BASIS OF FARMERS' CONSUMPTIVE WATER NEEDS,
Oklahoma Univ., Norman. Dept. of Geography.
For primary bibliographic entry see Field 6D.
W89-06922

FINANCIAL STABILITY OF PUBLICLY OWNED WATER SYSTEMS IN SOUTH CAROLINA,
Clemson Univ., SC. Graduate School

G. B. Tinubu.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8627211. Ph.D. Dissertation, 1986. 186p, 2 fig, 71 tab, 22 ref, 7 append.

Descriptors: *South Carolina, *Economic aspects, *Financing, *Public investment, *Political aspects, *Water supply, *Water conveyance, Public waters, Model studies, Surveys, Statistical methods.

Financial analysis tools were evaluated to determine their application in predicting financial difficulties of publicly owned water systems in South Carolina. Empirical results show that liabilities are more unstable than assets. But the current items information measure, which measures the extent of instability between current assets and liabilities, was shown to have the largest absolute value of all of the measures studied. The finding suggests that these water systems may be experiencing difficulty in meeting current obligations. The finding was supported by the fact that the only measure calculated from the income statement, the receipt-expenditure measure, also displayed relatively large values. The empirical results also indicate significant differences in the financial stability of many of the publicly owned water systems in the state of South Carolina. It is also indicated that political structure affects the financial stability of water systems as measured by information measures. The receipt-expenditure information measure best pointed out the differences among the various political structures. Water authorities exhibited the highest degree of instability with respect to receipts and expenditures. (Cremmins-AEPCO)
W89-06934

INSTITUTIONAL AND ECONOMIC ANALYSIS OF RURAL WATER SUPPLY INFRASTRUCTURE DETERIORATION IN NEW YORK STATE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6A.
W89-06936

SEASONAL PRICING OF MUNICIPAL WATER SUPPLIES WITH MULTIPLE STOCHASTIC INFLOWS AND STORAGE,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
M. McKee.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8619419. Ph.D. Dissertation, 1986. 94p, 35 fig, 8 tab, 46 ref, 3 append.

Descriptors: *Mathematical models, *Model studies, *Municipal water, *Water conveyance, *Water supply, *Pricing, Economic aspects, Stochastic hydrology, Cost analysis, Water demand, Computer models, Computer programs, Utah, Salt Lake City.

A mathematical model is used to estimate optimal reservoir operating rules and water prices simultaneously for a municipal water supply system having multiple stochastic sources with storage. The model explicitly includes multiple stochastic sources; treats supply costs as separate random variables for each source; expresses reservoir releases in terms of a linear decision rule that is neither an S- nor an SQ-type; and states the objective function in a way that is consistent with welfare economics principles. The solution of example problems is presented for the case of municipal water supply for Salt Lake City, Utah. The model obtained solutions to the multiple source, multiple reservoir, stochastic water supply problem without resorting to such restrictive assumptions or procedures as lumping all flows into a single random source, presuming perfect correlations between the seasonal inflows of the various sources, or the application of a linear decision rule with chance constraints that are set through political or other extra-market means on storage and release quantities. (Cremmins-AEPCO)
W89-06941

6D. Water Demand

MODELING INSTREAM RECREATIONAL BENEFITS,
Colorado State Univ., Fort Collins.
For primary bibliographic entry see Field 6A.
W89-06064

COMMUNITY WATER SUPPLY IN THE USSR,
For primary bibliographic entry see Field 5F.
W89-06239

COMMON PROPERTY AQUIFER AS A DIFFERENTIAL GAME,
Economic Research Service, Washington, DC. Resources and Technology Div.
For primary bibliographic entry see Field 4B.
W89-06575

WATER PLANNING: UNTAPPED OPPORTUNITY FOR THE WESTERN STATES,
Colorado Univ. at Boulder. School of Law.
For primary bibliographic entry see Field 6B.
W89-06598

RELATION OF STREAMFLOW TO HABITAT FOR ANADROMOUS FISH IN THE STILLAGUAMISH RIVER BASIN, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06832

GROUNDWATER WITHDRAWAL AND WATER LEVEL DATA USED TO SIMULATE REGIONAL FLOW IN THE MAJOR COASTAL PLAIN AQUIFERS OF NEW JERSEY,
Geological Survey, Trenton, NJ.
For primary bibliographic entry see Field 2F.
W89-06889

ECONOMIC ASPECTS OF WESTERN SURFACE WATER ALLOCATION,
Michigan Univ., Ann Arbor. School of Natural Resources.
M. R. Moore.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8702796. Ph. D. Dissertation, 1986. 191p, 6 fig, 8 tab, 130 ref, 4 append.

Descriptors: *Economic aspects, *Surface water, *Water allocation, *Model studies, *Water rights, Water storage, Queueing theory, Marketing, Water shortage, Water law.

The role was examined of the market and the activities of the federal and state governments in defining the necessary institutions for the efficient allocation of surface water. A formal model of the time-priority queue with minimal attention to other institutional aspects was extended to include a focus on the agricultural irrigation sector in the West. A framework for evaluating the alternatives of a water market and a water storage project was subjected to simulation analysis. Conflicts between diversionary and instream water users and between Native American surface water rights and established surface water users were examined. The water sharing principle was used as an integral element of generic proposals to resolve these conflicts. The time-priority queue that guides both the intrastate and, generally, the interstate allocation of water is the incorrect model for the property rights that should be traded in a water market. The correct form of water right is one that shares the risk of water shortages among the water users. The sharing results in clearer incentives to equate both long- and short-run marginal benefits in use across water appropriators. (Cremmins-AEPCO)
W89-06919

ALLOCATION OF GROUNDWATER RIGHTS ON THE BASIS OF FARMERS' CONSUMPTIVE WATER NEEDS,
Oklahoma Univ., Norman. Dept. of Geography.
C. Wijeyawickrema.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8702871. Ph.D. Dissertation, 1986. 220p, 33 fig, 19 tab, 207 ref, 6 append.

Descriptors: *Water allocation, *Water use, *Consumptive use, *Groundwater management, *Farming, Crop production, Statistical analysis, Groundwater basins, Groundwater irrigation, Irrigation requirements.

Variations in water needs in groundwater basins justifying smaller zones of different water allocation rates were studied along with differences between the estimated crop consumptive water needs of farmers and the quantity of water allocated to and reported as used by them. Whether farmers in Oklahoma differ significantly from those in the High Plains Region with regard to their views on groundwater policy was also studied. Statistical analysis indicated that the study area could be divided into at least four subdivisions with significant differences in water needs. Attempts to find a relationship between estimated crop consumptive water needs and the quantity of water allocated and reported as used by irrigated farms were not very successful. A comparison of water used with water allocated indicated that only a few farmers used water entitlement to full capacity. But many farmers used over 100% in excess of their legally allowed limits. Cotton, wheat, and alfalfa showed a strong link with the quantity of water used. Questionnaire data on the farmers' perception of groundwater management policies indicated that farmers in the study area had similar views to those of farmers in the High Plains Region. Most of the farmers were not strongly opposed to the introduction of controls to regulate water use. (Cremmins-AEPCO)
W89-06922

SEASONAL PRICING OF MUNICIPAL WATER SUPPLIES WITH MULTIPLE STOCHASTIC INFLOWS AND STORAGE,
Utah State Univ., Logan. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 6C.
W89-06941

WATER MANAGEMENT FOR LOWLAND RICE IRRIGATION,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 3F.
W89-06962

COMPUTER DECISION SUPPORT FOR WATER SUPPLY DEVELOPMENT,
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 3F.
W89-06968

ANALYTICAL MODEL FOR ESTABLISHING WATER RESOURCES DEVELOPMENT PRIORITIES,
Oklahoma Univ., Norman. School of Civil Engineering and Environmental Science.
For primary bibliographic entry see Field 6A.
W89-06969

DAILY URBAN WATER USE ANALYSIS AND FORECASTING,
Texas Univ. at Austin. Graduate School.
S. P. Miaou.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8700245. Ph.D. Dissertation, 1986. 222p, 48 fig, 11 tab, 73 ref.

Descriptors: *Water use, *Forecasting, *Model studies, *Urban planning, Rainfall rate, Temperature distribution, Optimization, Computer models, Statistical models, Adaption.

Adaptive models using the Kalman filter were developed for daily urban water use forecasting in terms of base use, weekly cycle, potential seasonal use, and irregular use. A daily forecasting model updates model parameters and forecasts recursively as new data becomes available. Heat function and rainfall effects are estimated using an optimization technique. The white noise property of the one-step-ahead forecast error is used in Kalman's algorithm. During rainy periods, large prediction errors often occur and the states of the system are then overly adjusted in the updating process, which affects the maximum likelihood estimation of the unknown state covariances. A likelihood function, which selects only those samples with minimal rainfall effects, is proposed and an optimization solution is obtained. Results from a forecast simulation indicate that the adaptive models do provide slightly better forecast performance for lead-times from one day up to about two weeks. But the improvement tends to decline as the lead-time increases, and the adaptive model eventually performs worse than the constant parameter models. (Cremmins-AEPCO)
W89-06975

6E. Water Law and Institutions

EFFECT OF ACID RAIN LEGISLATION ON THE ECONOMICS OF CO2 RECOVERY FROM POWER PLANTS,
Bowling Green State Univ., OH. Dept. of Physics.
For primary bibliographic entry see Field 5G.
W89-05809

RHODE ISLAND VOLUNTEERS MONITOR THE HEALTH OF SALT PONDS,
Rhode Island Univ., Kingston. Graduate School of Oceanography.
For primary bibliographic entry see Field 5G.
W89-05910

FUTURE LEGAL REGULATION OF WEATHER MODIFICATION,
Brigham Young Univ., Provo, UT. J. Reuben Clark Law School.
R. J. Davis.
Journal of Irrigation and Drainage Engineering JIDEDH, Vol. 11, No. 4, p 705-710, November 1988. 26 ref.

Descriptors: *Water law, *Weather modification, *Regulations, *Legal aspects, Liability, Cloud seeding, Permits, Government agencies, Planning, Insurance.

Legal regulation of weather modification is being altered by regulatory de-emphasis, cost sharing, and liability law changes. With regulatory de-emphasis, weather modification regulation activities have been carried out by requiring professional licenses of weather modifiers, prohibiting them from running projects without operational permits, insisting they keep detailed records of their cloud seeding activities and mandating periodic submission of reports. Even though control by the bureaucracy over weather modification is less now than it has been, this trend will bring only de-emphasis in government intervention, not complete deregulation. With cost sharing, weather modification project sponsors who use government funds are being required by law and executive policy to bear a larger share of operational and regulatory costs. Finally, with liability law changes, operators and their sponsors now have less exposure to legal liability than before because legislative tort law reform is changing substantive and procedural liability law and the law of damages. This should affect future liability insurance availability, coverage and cost. (Miller-PTT)
W89-05965

WATER POLLUTION CONTROL ADMINISTRATION IN JAPAN,
Environment Agency, Tokyo (Japan). Water Quality Bureau.
M. Ozawa.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 1-11, 1988. 6 fig, 3 tab.

Descriptors: *Water pollution control, *Administrative agencies, *Japan, Legislation, Water quality standards, Environmental protection, Water quality management, Environmental policy.

In the 1960's environmental pollution began to pose a serious problem in Japan. To cope with the situation, the Basic Law for Environmental Pollution Control and other related laws and regulations were legislated. In 1970 in particular, a Central Headquarters for Environmental Pollution Control (headed by the Prime Minister) was established as the center of environmental pollution control administration, and 14 pollution-related laws including an amendment to the Basic Law for Environmental Control were enacted by the so-called environmental pollution control session of the Diet at the end of that year. Along with the legislation of the related laws and regulations, the Environment Agency was inaugurated on July 1, 1971 in order to obtain comprehensiveness and unity in environmental administration. The agency took over and coordinated the administrative measures on the prevention of environmental pollution and the conservation of nature, which had previously been handled by various related ministries and agencies, and has been furthering these measures comprehensively. (Author's abstract)
W89-06014

WATER RESOURCES POLICY: OLD MODELS AND NEW REALITIES,
Arizona Water Resources Research Center, Tucson.
H. J. Cortner, and J. Auburg.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1049-1056, October 1988. 43 ref.

Descriptors: *Policy making, *Administrative decisions, *Legislation, *Water resources institutes, *Decision making, *Resource allocation, Models, Political aspects, Governmental interrelations, Water resources development.

Policy models are designed to help describe the principal actors and processes by which decisions are made, but they also have prescriptive roles. They advance some interests over others and reflect policy biases about the nature of the desired policy outputs. Historically, federal water resources development policy could be most easily explained by reference to subsystem government (or iron triangles), a policy model that describes how local water interests, federal water construction agencies, and public works committees coalesce to effectively dominate the decisionmaking process by which water projects are authorized and funded. The programs and activities of the U.S. Army Corps of Engineers and the U.S. Bureau of Reclamation are used to explain how prescriptive elements of two other policy models, administrative rationality and market allocation, have affected the traditional alignment of actors and policy outputs. (Author's abstract)
W89-06061

INSTITUTIONS AND ECOSYSTEM REDEVELOPMENT IN GREAT LAKES AMERICA WITH REFERENCE TO BALTIC EUROPE,
Waterloo Univ. (Ontario). Dept. of Environment and Resource Studies.
G. R. Francis.
Ambio AMBOCX Vol. 17, No. 2, p 106-111, 1988. 27 ref.

Descriptors: *Great Lakes, *Baltic Sea, *Regional development, *Management planning, *Water resources development, Project planning, Ecosystems, Fisheries, Lake restoration, Judicial decisions, International commissions, Jurisdiction, Future planning, Research priorities, Institutions.

Governance arrangements are evolving to transcend interjurisdictional boundaries in the Baltic Sea region and in the Great Lakes. In each of these basins, two commissions are leading the way, one related to environmental concerns and the other to fishery interests. The two commissions will collaborate in the context of an ecosystem approach. The governance arrangements in the two basins have closer similarity with respect to function than to form. Progress toward sustainable redevelopment of degraded waters and fisheries in these basins has as a prerequisite the further evolution of transboundary research, communication and involvement by nongovernmental personnel. Some socioecological guidelines for ecosystem redevelopment are suggested for other regions where ecosystem redevelopment is required: (1) develop a widely accepted goal statement for the collective regional ecosystem redevelopment effort; (2) expand the scope of the multi-jurisdictional agreements from a resource focus to an ecosystem focus; (3) specify ecosystemic criteria and indices needed to describe or define ecosystem redevelopment; (4) establish basic ground rules for directing ecosystem redevelopment; and (5) accept and encourage a plurality of initiatives within the overall basic ground rules, in recognition that the development of collective competencies to pursue ecosystem redevelopment will come from experiential learning. (Geiger-PTT)
W89-06165

DER WETLANDS PROTECTION ACTION PLAN,
Pennsylvania Dept. of Environmental Resources, Harrisburg.
A. A. Davis.
Water Pollution Control Association of Pennsylvania Magazine, Vol. 22, No. 1, p 18-22, January-February 1989.

Descriptors: *Regulations, *Administrative regulations, *Environmental protection, *Environmental policy, *Wetlands, *Pennsylvania, Regional development, State jurisdiction.

The goal of the Pennsylvania DER (Department of Environmental Resources) wetlands protection policy is to prevent destruction, degradation, or significant impact of wetlands where practicable alternatives exist and to minimize impacts or replace wetlands where impacts are unavoidable. DER will adopt the three-parameter approach found in the EPA Wetland Identification and Delineation Manual and evaluate its various existing program activities to develop means of identifying wetlands early in the development process. Proposed amendments to Chapter 105 Regulations were designed to clarify and further define the actions DER will take in the protection of wetlands under Chapter 105. Mitigation standards will be established to replace the wetlands values lost or degraded. In order to ensure that growth and development in the margins adjacent to wetlands are carried out in an environmentally sensitive manner, DER proposes to establish a 100 ft impact area around all wetlands and a 300 foot impact area around 'Exceptional Value' wetlands. (White-Reimer-PTT)
W89-06406

SHOULD WATER DISTRICT TREATMENT PLANTS BE REGIONALIZED,
For primary bibliographic entry see Field 5D.
W89-06552

AUSTRALIAN RIVERS AND STATUTE LAW,
Australian National Univ., Canberra. Centre for Resource and Environmental Studies.
S. R. Dovers, and D. G. Day.
Environmental and Planning Law Journal EPLJEX, Vol. 5, No. 2, p 98-108, June 1988. 1 fig, 3 tab, 29 ref.

Descriptors: *Australia, *Legal review, *Legislation, *River regulations, *Water law, Legal aspects, Riparian waters, River management.

The legislative framework surrounding the management of rivers in Australia is surveyed. The framework is identified as including principal and other water Acts, river improvement Acts, some region or project-specific statutes, and an range of 'generic' legislation across the States. The adequacy of the legislation is assessed in terms of the management of rivers for a range of non-extractive

water uses such as recreation, wildlife habitat and ecological integrity. Some possible solutions to identified shortcomings are presented. Riverine resources management in Australia is inadequate, disjointed and often lacking in clear direction. This can be seen to be a result of the absence of political desire or will as well as a lack of coherence and defined social goals and statutory objectives in the array of legislation that impacts on rivers; a problem which can in fact be observed throughout the wider field of environmental and resource law. (Author's abstract)
W89-06591

REMINING AND THE WATER QUALITY ACT OF 1987: OPERATORS BEWARE,
Reed, Smith, Shaw and McClay, Pittsburgh, PA.
M. J. Hackett.
Columbia Journal of Environmental Law CJELE8, Vol. 13, No. 1, p 99-128, 1988. 170 ref.

Descriptors: *Coal mining, *Legal review, *Regulations, *Coal mines, *Water pollution control, *Clean Water Act, Mine wastes, Reviews, Remaining.

In 1977, the Abandoned Mine Reclamation Fund created under the Surface Mining Control and Reclamation Act (SMCRA) was seen as a major breakthrough towards cleaning up environmental hazards generated from abandoned mines. Recently, however, it has become apparent that only 10 to 20% of abandoned coal lands will be reclaimed under SMCRA. As a result, the cry is no longer to reclaim; the cry today is 'Remine.' This article explores first the incentives to remining, specifically the possibility of incurring statutory and common law liability when working previously mined areas. The recent amendments to the Clean Water Act (CWA) are then analyzed to determine whether the pertinent provisions in the amendments afford sufficient protection to overcome the disincentives to remining, by making it possible to remine without responsibility for abatement of pre-existing conditions. In conclusion, operators who want to mine abandoned mine areas may expose themselves to substantial liability. However, remining can result in a reduction in the amount of pollution generated by a site, and can also result in reclamation of abandoned mine lands at no cost to the government. (VerNooy-PTT)
W89-06592

SOURCE REDUCTION OF TOXIC WASTE: IMPLICATIONS FOR WESTERN WATER POLICY,
Southern California Metropolitan Water District, La Verne.
For primary bibliographic entry see Field 5G.
W89-06593

FEDERAL WATER POLICY IN THE UNITED STATE--AN AGENDA FOR ECONOMIC AND ENVIRONMENTAL REFORM,
Z. Willey, and T. Graff.
Columbia Journal of Environmental Law CJELE8, Vol. 13, No. 2, p 325-356, 1988. 4 fig, 2 tab, 63 ref.

Descriptors: *Economic aspects, *Water policy, *Environmental policy, *Policy making, *Value, *Federal jurisdiction, Administrative agencies, Water allocation, Nonconsumptive use.

Several principles for the reform of federal water policy are revealed in this discussion of economic and environmental factors. Water policy in the United States is outmoded and irrational. The federal agencies which are responsible for various aspects of the nation's water policy often fail to operate in a coherent manner in part because their respective authorizing missions are at best in need of modernization and at worst inconsistent. Valuation is another problem area. The economic value of water resources is well-defined for some uses and not for others. Allocation of water resources to alternative uses involves a complex mix of market and political processes. Policy reforms must also address the manner in which private and public allocation systems can be adjusted in recognition of the shift in demand from comsumptive uses to recreation, drinking water quality, fisheries, and wildlife habitat. As demand for public water uses is rising, supply is contracting. Existing federal regulatory and subsidy policies are increasingly coming under criticism. Alternatives which deliver improved environmental quality at a reasonable economic cost and which are consistent with American traditions favoring voluntarism and disfavoring government coercion seem to have a promising future. Entrenched interests, however, will contest these policy reforms for a variety of reasons. (VerNooy-PTT)
W89-06594

BREATHING LIFE BACK INTO A DROWNED RESOURCE: MITIGATING WILDLIFE LOSSES IN THE COLUMBIA BASIN UNDER THE NORTHWEST POWER ACT,
S. Brown.
Environmental Law, Vol. 18 EVLWA8, No. 3, p 571-596, Spring 1988. 101 ref.

Descriptors: *Columbia River Basin, *Dam effects, *Wildlife conservation, *Wildlife management, *Planning, *Environmental policy, *Northwest Power Act, Hydroelectric plants, Wildlife habitats, Regulations.

The development of the Columbia River Basin hydropower system has not only reduced the Basin's fishery, but has also harmed wildlife habitats and populations. The Northwest Power Act contains measures to redress both fish and wildlife losses. Nonetheless, measures to mitigate wildlife losses have thus far been overshadowed by the attention given to restoring fish populations. This article examines the Columbia Basin Fish and Wildlife Program from the perspective of wildlife. First it is argued that the Northwest Power Planning Council must take a more active role in implementing wildlife mitigation proposals that have been developed by wildlife agencies and tribes. Also examined is the funding of mitigation projects. It is concluded that the Northwest Power Act contemplates full rate-payer funding of mitigation projects. (Author's abstract)
W89-06595

CITIZEN PARTICIPATION AND ADMINISTRATIVE DISCRETION IN THE CLEANUP OF NARRAGANSETT BAY,
K. H. Goslant.
Harvard Environmental Law Review HELRDC, Vol. 12, No. 2, p 521-568, 1988. 221 ref.

Descriptors: *Cleanup, *Narragansett Bay, *Public participation, *Water pollution control, Water policy, Policy making, Legal aspects, Administration, Reviews, Environmental quality.

A central premise in much of the recent discussions on citizen movements is that the American political process is animated by conflicting notions of legitimacy. While there is recognition that the demands of time and technical competence have made it increasingly difficult for ordinary citizens to participate effectively in government policy-making, there are deeply held beliefs that the wielders of government power must be held accountable to the public. This article examines the efforts of Save the Bay, a citizens group centered in Providence, Rhode Island, to protect and to restore the environmental quality of Narragansett Bay. General aspects about the organization and objectives are discussed, as well as Save the Bay's dealings with the government agencies responsible for regulating sources of pollution. The last part of this article compares the experience in Rhode Island with the efforts to clean up Boston Harbor; particular emphasis is given to the role played in each case by the courts and by the public authorities specially created to handle water quality problems. Throughout the article, special consideration is given to the different contexts in which the conflict between administrative discretion and public accountability occurs, as well as the various attempts to reconcile this conflict. (Author's abstract)
W89-06596

REGULATING DISCHARGES INTO GROUNDWATER: THE CRUCIAL LINK IN POLLUTION CONTROL UNDER THE CLEAN WATER ACT,
M. C. Wood.
Harvard Environmental Law Review HELRDC, Vol. 12, No. 2, p 569-626, 1988. 277 ref.

Descriptors: *Regulations, *Groundwater pollution, *Water pollution control, *Clean Water Act, Legal review, Legal aspectsEnvironmental policy, Water law, Navigable waters, Tributaries, Federal jurisdiction, Water quality control, Permits, Industrial wastewater, Hydrologic systems.

Groundwater contamination is one of the most urgent and, at the same time, neglected environmental problems facing our nation. Existing legislation leaves a large regulatory gap which allows industrial dischargers to pollute groundwater. The most viable and effective way of abating these activities is by bringing them within the scope of section 402 of the Clean Water Act, thereby controlling surface water and groundwater quality in a coordinated and hydrologically sound fashion. The legal framework of groundwater legislation is discussed in this article, as well as a legal definition of point source and related regulation and legal cases. An extensive section presents a theory under which some groundwater could be regulated under section 402 by casting it as 'navigable waters'. Because of its hydrological nexus with surface water, groundwater fits easily into the class of 'tributary water'. The case law is receptive to federal regulation of such tributary groundwater, despite some courts' refusal to include nontributary groundwater. Efforts to protect surface water quality could benefit tremendously from the precedents established in this area. The final section in this article offers guidance as to which strategy (regulation or ad hoc permitting) the EPA should embrace. Direction for making a choice between the two strategies, is presented. Equipped with compelling legal theories for ushering groundwater into section 402, it is hoped that the EPA will take the initiative in ensuring that our nation's vital groundwater resources are preserved for future generations. (VerNooy-PTT)
W89-06597

WATER POLLUTION LAW: PLUGGING THE LEAKS,
N. Hawke, and J. Himan.
Journal of Planning and Environmental Law JPELAL, p 670-673, October 1988. 11 ref.

Descriptors: *Water pollution control, *Legislation, *Water law, *Regulations, Agricultural pollution, Water quality management, Great Britian, Legal review, Enforcement, Municipal wastes.

The Third Report of the House of Commons Environment Committee (Session 1986-87), Pollution of Rivers and Estuaries, highlights anxieties about deterioration in water quality, chiefly attributed to the quality of effluent at sewage works and the incidence of agricultural pollution in Great Britain. A number of issues are canvassed by the Report which concludes with recommendations aimed at dealing with the two main problems of water authorities' own discharges and pollution from agricultural processes. Each of the main issues is examined in this article against the background of Part II of the Control of Pollution Act, 1974. Water quality management is discussed, as well as the problem of prosecution and enforcement. Part II as a whole is in imminent need of review. Only then can the overall structure of the law and its enforcement be reviewed on a current basis in the light of many factors, including the present recommendations of the Environment Committee's report. (Author's abstract)
W89-06599

RIVER POLLUTION: A CASE FOR A PRAGMATIC APPROACH TO ENFORCEMENT,
Dundee Univ. (Scotland). Dept. of Law.
P. Q. Watchman, C. R. Barker, and J. Rowan-Robinson.
Journal of Planning and Environmental Law JPELAL, p 674-679, October 1988. 20 ref.

Descriptors: *River regulations, *Scotland, *Law enforcement, *Water pollution prevention, *Water policy, Great Britain, Water policy, Regulations, Stream pollution.

The Environment Committee of the House of Commons in their recent report on 'Pollution of Rivers and Estuaries' commented that 'compared with the number of reported pollution incidents, there are relatively few prosecutions each year.' The Committee concluded that 'water authorities should seek to enforce the law and prosecute more frequently than they have done to date...'. The report relates only to England and Wales, but statistics show that the problem in Scotland is broadly the same--of the order of 1.2-1.3% prosecuted. Research suggests that this does not represent an unduly relaxed approach by the River Purification Boards; neither is the thought that more frequent prosecution is necessarily consistent with promoting the objectives of the legislation. To understand the enforcement process and the role of the criminal law in the context of river pollution, an examination of a considerable number of inter-related factors is reviewed. These fall under the categories of enforcement policy, resources for enforcement, the problem of the 'reputable' offender, and penalties for regulatory crime. It may be that prosecutions should properly be regarded as failures, due to the inability of the water authorities to achieve compliance, rather than evidence of pusillanimity or lax enforcement. (VerNooy-PTT)
W89-06600

TRIBAL WATER MANAGEMENT HANDBOOK.
American Indian Resources Inst., Oakland, CA.
American Indian Resources Institute. 1988. 208p.

Descriptors: *Water management, *Water law, *Policy making, *Handbooks, *Indian water law, Decision making, Water rights, Management planning, Watershed management, Water quality, Hydrology, Water resources development, Economic aspects, Social aspects, Reservation doctrine, Federal jurisdiction, State jurisdiction.

The history of Indian water law has been steeped in conflict, deprivation of water to reservations, and powerful but unrealized declarations of extensive Indian rights. Indians and non-Indians have bent their past attention on determination of Indian reserved water rights through legal action-a slow, expensive process. Scores of cases have been commenced in, or are headed for, state courts, following two decades of disputes over whether a state or a federal forum is appropriate. However, the results of Indian reserved rights quantification litigation and negotiation are beginning to convert theoretical rights into tangible assets, and Indian tribes are now confronting the question of how to put their water rights to use. Plainly, tribes are moving from the realm of legal theory and advocacy into the practicabilities of making policy choices on what to do with their valuable assets. This handbook is designed to provide tribal decision-makers and water managers with a background in the diverse expertise they need to carry out their daily missions. Questions of law and policy permeate water management. Thus, Part I provides the reader with an historical backdrop and a discussion of current trends in these areas. The science of watershed management is explored in Part II in chapters on basic hydrology and water quality problems. The emphasis of the handbook is, as it must be for successful Indian tribal stewardship of water resources, on integrating technically competent management with sound long-range policy directions. Those directions must be the synthesis of economic and cultural objectives. They can be achieved using a variety of tools-including benefit/cost analysis, inventories of tribal resources, comprehensive planning, tribal regulation through water code development, cooperative regulatory efforts with state and federal agencies and other tribes, and financing water development. These methods are discussed in Parts III and IV. (Lantz-PTT)
W89-06628

ROLE OF EPA'S OFFICE OF RESEARCH AND DEVELOPMENT IN THE STANDARD SETTING PROCESS FOR DRINKING WATER,
Environmental Protection Agency, Cincinnati, OH. Drinking Water Research Div.
For primary bibliographic entry see Field 5G.
W89-06641

GUIDELINES FOR INSTITUTIONAL ASSESSMENT: WATER AND WASTEWATER INSTITUTIONS,
Water and Sanitation for Health Project, Arlington, VA.
D. Cullivan, B. Tippett, D. B. Edwards, F. Rosensweig, and J. McCaffery.
Water and Sanitation for Health Project, Washington, DC. WASH Technical Report No. 37, February 1988. 74p. WASH Contract 5942-C-00-4085-00, Project 936-5942.

Descriptors: *Water treatment facilities, *Wastewater facilities, *Utilities, *Management planning, *Institutions, *Standards, Water quality, Water treatment, Wastewater treatment, Personnel, Performance evaluation, Administration, Employee relations, Operating policies, Training, Data acquisition, Communication.

This document provides a set of procedures which can assist in the diagnosis of institutional deficiencies in the water and wastewater sector. Because institutional problems are interwoven through technical and functional areas, the process of diagnosing these problems requires a fundamentally different approach to problem identification. The approach used in these guidelines focuses on problem definition and identification in institutional areas; it is interdisciplinary and seeks to identify crosscutting issues; and it is designed to avoid the temptation to jump to quick-fix solutions while ignoring the more difficult and basic issues. The institutional assessment procedures presented are based upon the use of pre-identified institutional performance categories. A performance category is a set of related skills, procedures and capabilities which define a particular area of institutional function or performance. Based on field research carried out to develop these guidelines, nine categories were identified: (1) organizational autonomy; (2) leadership; (3) management and administration; (4) commercial orientation; (5) consumer orientation; (6) technical capability; (7) developing and maintaining staff; (8) organizational culture; and (9) interactions with key external institutions. In designing the guidelines it was assumed that normally a donor/lender agency would sponsor the assessment. However, it is also possible that the general manager of an institution might wish to request an assessment and manage it internally. There are many variations in background possible for the assessment team which will use these guidelines. However, there are certain skills and knowledge which all team members must have in order to carry out the assignment. These include experience and/or demonstrated skills in: data gathering techniques, familiarity with utility operations, development perspective/project development, and cross-cultural sensitivity. (Lantz-PTT)
W89-06678

ECONOMIC ASPECTS OF WESTERN SURFACE WATER ALLOCATION,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6D.
W89-06919

POLITICAL ECONOMY OF INSTITUTIONAL INNOVATION: COALITIONS AND STRATEGY IN THE DEVELOPMENT OF GROUNDWATER LAW,
Wisconsin Univ.-Madison.
S. C. Nunn.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8605706. Ph.D. Dissertation, 1986. 334p, 7 fig, 26 tab, 144 ref, 2 append.

Descriptors: *Policy making, *Law enforcement, *Legal aspects, *Institutional constraints, *Groundwater management, *Political aspects, *Decision making, Model studies, Judicial decisions, Distribution patterns, Cost-benefit analysis, Texas, New Mexico, High Plains, Roswell artesian basin.

A framework was developed for an economic approach to rulemaking and rule change and applied to the development of groundwater rules using models of the high plains region of Texas and the artesian basin near Roswell, New Mexico. The role of collective action in policy making is considered and reasons are investigated for the lack of success of policy recommendations that are based solely on efficiency analysis. A distribution-of-benefits criterion based on the collective decision making process is proposed. Three model decision-making relationships are also proposed: the distribution-of-costs problem, the prisoners' dilemma and the assurance problem, under which rational individuals are motivated to act collectively or adopt a rule. The relation of the political decision to adopt a rule and the economic decision to behave in conformance to the rule once it is adopted is also investigated. Focus of concern on the prisoners-dilemma type decision and its enforcement and incentive-compatibility problems may be misplaced. The difficulties presented by the distribution problem suggest that research on the role of institutions in generating information might be a more fruitful area of concentration. (Cremmins-AEPCO)
W89-06939

STRUCTURES IN THE STREAM: A HISTORY OF WATER, SCIENCE, AND THE CIVIL ACTIVITIES OF THE U.S. ARMY CORPS OF ENGINEERS, 1700-1861,
Carnegie-Mellon Univ., Pittsburgh, PA. Coll. of Humanities and Social Sciences.
T. A. Shallat.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8702908. Ph.D. Dissertation, 1986. 495p, 12 tab, 642 ref.

Descriptors: *Civil engineering, *Water policy, *Navigation, *History, *Policy making, Hydraulic engineering, Surveys, Watercourses, Hydrography, Political aspects, Topography.

The current policy debate is reviewed in relation to three centuries of competition between technologies of navigation improvement and the professional cultures of civil engineers. From 1802 to 1861, the Corps of Engineers entered areas of hydraulic engineering that remain in the Federal jurisdiction: dredging, jetty construction, lock and dam design, canal excavation, river improvement, flood control, and hydrographical surveying. French and British practices are compared with those of American engineers. Reconnaissance of water and land is based on the art of surveying, military surveyors, long expeditions, and the topographer's measure of the wild. Watercourses are examined against the background of hydrography at West Point, lessons in hydraulic construction, the Chesapeake and Ohio Canal, and the diffusion of the Officers' Science. The organization of the Topographic Bureau is traced and river and harbor improvement are considered in political terms. Historical foundations of anti-Crops of Engineers critiques are described. (Cremmins-AEPCO)
W89-06967

WATER RESOURCES AND RURAL GROWTH: A POLICY ANALYSIS OF WATER RESOURCE MANAGEMENT IN THE SIERRA NEVADA FOOTHILLS,
California Univ., Santa Barbara.
For primary bibliographic entry see Field 6B.
W89-06970

6G. Ecologic Impact Of Water Development

INFLUENCE OF REGULATION ON ENVIRONMENTAL CONDITIONS AND THE MA-

CROINVERTEBRATE COMMUNITY IN THE UPPER COLORADO RIVER,
Colorado State Univ., Fort Collins. Dept. of Zoology and Entomology.
R. B. Rader, and J. V. Ward.
Regulated Rivers Research and Management RRRMEP, Vol. 2, No. 5, p 597-618, November-December 1988. 9 fig, 8 tab, 60 ref. DOE Contract DE-AC09-76SROO.

Descriptors: *Colorado River, *Regulated flow, *Species diversity, *Macroinvertebrates, *Environmental effects, *Water temperature, Insects, Midges, Stoneflies, Caddisflies, Mayflies, Animal populations, Detritus, Algae, Seasonal variation.

The influence of stream regulation on environmental conditions and concomitant alterations of macroinvertebrate community structure was determined from field studies conducted from September 1981-June 1983 at three sites on the upper Colorado River. Site 1 (reference site) was located above Granby and Shadow Mountain Reservoirs, a deep-release storage impoundment, whereas sites 2 (regulated site) and 3 (recovery site) were located 0.4 and 4.0 km, respectively, below the dam. Although macroinvertebrate diversity was reduced at the regulated site compared to both the reference and recovery sites, the number of taxa (43) was considerably higher than values reported from studies of other regulated streams in the Rocky Mountains. Macroinvertebrate mean annual density in the regulated site was 20 times higher than at the reference site and slightly higher than the recovery site. The regulated site was characterized by the absence of heptageniid mayflies, reductions in stoneflies, caddisflies, shredders, and predators, and high densities of Baetis spp., Ephemerella infrequens, chironomids, and non-insect taxa. Many of these faunal changes are attributed to alterations in the temperature regime induced by regulation and to changes in the source and temporal sequencing of organic detritus. Although the number of annual degree days actually was greater below the dam than above the reservoir, other components of the thermal regime were severely altered by regulation. At the regulated site the primary source of coarse organic detritus was authochthonous (decaying algae) with a vernal pulse, in contrast to the typical autumnal pulse of allochthonous leaf litter. There was no evidence that the greater substrate permeability and flow predictability below the dam directly influenced the reduction of species. (Author's abstract)
W89-05839

EFFECTS OF DEVELOPMENT OF A TIDAL BARRAGE UPON THE WATER AND SEDIMENT QUALITY OF THE MERSEY ESTUARY (U.K.) AND ITS BIOTA,
RPS Environmental Services Ltd., Mold (Wales).
D. C. Hockin, and D. M. Parker.
Water Science and Technology WSTED4, Vol. 20, No. 6/7, p 229-233, 1988. 4 tab, 8 ref.

Descriptors: *Dam effects, *Dikes, *Water quality, *Marine sediments, *England, *Aquatic life, *Water resources development, *Environmental effects, *Tidal powerplants, *Estuaries, Pollution load, Water quality management, Waste disposal, Recreation, Heavy metals, Nutrients, Waterfowl, Light Transmission, Oxygenation.

The prime constraint upon the development of a tidal power generating barrage is the use of the Mersey estuary as a waste disposal facility. Historical disposal of persistent wastes continues to cause environment problems, even though modern practices have resulted in a reduced pollution load. Mercury and lead have the greatest environmental significance, although with reference to barrage operation the nutrient status and increased transmission of light through less turbid water will be of equal or greater importance. A constraint upon the recreational use of the impounded water body will be the unacceptable numbers of fecal bacteria. A criterion for the design of the barrage should be the maximization of the volume of water entering on each tidal cycle to disperse nutrients and pollutants and import as much oxygen as possible. This will minimize the increase of retention time and reduce the probability of methylation of mercury within the sediment. Additionally it will have implications for the feeding behavior of the internationally important wildfowl populations. (Author's abstract)
W89-06038

SALT-INDUCED MANGANESE SOLUBILIZATION IN CALIFORNIA SOILS,
California Univ., Riverside. Dept. of Soil and Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-06082

EFFECTS OF DEPOSITED SAND ON OVA SURVIVAL AND ALEVIN EMERGENCE IN BROWN TROUT (SALMO TRUTTA L.),
Umea Univ. (Sweden). Dept. of Animal Ecology.
T. I. Olsson, and B. G. Persson.
Archiv fuer Hydrobiologie AHYBA4, Vol. 113, No. 4, p 621-627, October 1988. 3 fig, 2 tab, 18 ref.

Descriptors: *Drainage effects, *Spawning, *Trout, *Fish eggs, Land use, Dredging, Sediment transport, Fisheries, Gravel, Hatching, Environmental effects, Sand, Ecological effects.

Land drainage and other land use activities can result in substantial increase in the quantity of sediment transported by streams and rivers. When these solids are deposited on the spawning sites of brown trout, harmful effects on reproduction can be expected. When 20% (volume) sand is added to coarse gravel in simulated redds, a decrease from 90% to 28% in ova and embryo survival was found. Furthermore, a high proportion (55%) of surviving alevins emerged at a premature stage. The high proportion of premature emergence also caused a less synchronous total emergence. Both premature emergence and extension of the emergence period is expected to reduce the postemergent survival of brown trout alevins mainly due to increased vulnerability to predators. (Author's abstract)
W89-06147

SOME EFFECTS OF DAMS ON WILDLIFE,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Environmental Engineering.
W. Liao, D. S. Bhargava, and J. Das.
Environmental Conservation EVCNA4, Vol. 15, No. 1, p 68-70, 1988. 2 fig, 9 ref.

Descriptors: *Dam effects, *Environmental effects, *Wildlife habitats, *Flooding, Ecological effects, Endangered species, India, Africa, Water birds.

Numerous ill-effects of dam construction have been documented among which are loss of food sources and habitats of wildlife, reduction of reservoir capacity from the deposition of solids carried down by the upstream river, destruction of fish spawning areas, reduction in dissolved oxygen content due to thermal discharges from power stations employing cooling waters, changes in water quality due to eutrophication caused by reduced flows, and changes accompanying reservoir construction. The most significant effects of dams from the viewpoint of wildlife is the loss of land-including forests, valleys, marshy wetlands, etc.-that serves as the primary habitat and food-source of birds, wild mammals, plants, and the other components of natural ecobiomes and ecosystems. The construction of reservoirs may radically change the habitat conditions of the terrestrial wildlife living downstream from the impoundment by changing the groundwater levels, vegetation, and food sources. Changes were noted in fish populations on the Kariba reservoir; changes in fish abundance and species composition occurred above and below the dam. On the flood plains of Africa that have been dammed, many species that were once abundant have become endangered. Dams have also caused resettlement problems among the affected human populations in the reservoir areas. (Geiger-PTT)
W89-06160

BALTIC EUROPE, GREAT LAKES AMERICA AND ECOSYSTEM REDEVELOPMENT,
Gdansk Univ. (Poland). Dept. of Economic Geography of the Sea.
R. Serafin, and J. Zaleski.
Ambio AMBOCX, Vol. 17, No. 2, p 99-105, 1988. 2 fig, 7 tab, 42 ref.

Descriptors: *International agreements, *Ecosystems, *Regional development, *Lake restoration, *Great Lakes, *Baltic Sea, Project planning, Water resources development, Social aspects, Political aspects, Economic aspects, Future planning.

Efforts to redevelop large degraded ecosystems are often constrained as much by social and economic processes as by natural ones. Effective redevelopment strategies for Great Lakes and Baltic ecosystems are likely to be those that best contend with the long-term change of many important cultural processes. Great Lakes America and Baltic Europe are geographically defined economic regions closely tied to the large aquatic ecosystems that lie in their midst. Current experience of effective redevelopment in Baltic and Great Lakes ecosystems remains fragmented. In response to degradative ecological changes, there have been attempts to design and implement interjurisdictional management strategies such as the 1972 Great Lakes Water Quality agreement and the 1974 Helsinki Convention. Four perspectives are outlined for redevelopment efforts in the Great Lakes and Baltic regions. First, the focus of research should be on causes not symptoms of area degradation. Secondly, a synoptic perspective of the past and future population, agriculture, energy and trade patterns should provide the basis for economic decision-making in the area. Thirdly, a cultural space is highlighted in which economic and land-use planning, industrial development, political representation and fiscal budgets take place within geographically defined jurisdictions. Finally, a broad-scale long-term development process (50 to 100 years) is stressed. (Geiger-PTT)
W89-06163

OVERVIEW OF ENVIRONMENTAL PROBLEMS IN THE EAST ASIAN SEAS REGION,
Philippines Univ., Diliman, Quezon City. Marine Science Inst.
E. D. Gomez.
Ambio AMBOCX, Vol. 17, No. 3, p 166-169, 1988. 22 ref.

Descriptors: *Coral reefs, *Mangrove swamps, *Fisheries, *Water pollution effects, *Seas, Management planning, Water resources development, Resources management, Marine resources, Environmental effects, Environmental protection, Chlorinated hydrocarbons, Hydrocarbons, Heavy metals.

The environmental problems of the seas adjacent to the Southeast Asian States (Indonesia, Malaysia, the Philippines, Singapore and Thailand) that are involved in the East Asian Seas Action Plan (UNEP) are reviewed. Large destruction of coral reefs is occurring due to net fishing and dynamite techniques. The mangrove swamps have been destroyed largely due to clearing for agriculture, aquaculture, and human settlement. In addition mangroves are exploited for timber, firewood, charcoal, and chemicals. Fisheries in the ASEAN region have declined due to over-fishing, destruction of habitat, and marine pollution. Chief pollutants in the Southeast Asian waters include chlorinated hydrocarbons, petroleum hydrocarbons, heavy metals, and sewage. All the ASEAN countries have established ministries or bureaus to deal with environmental protection. Initial steps have been taken through the East Asian Seas action Plan to ensure future marine environmental protection. (Geiger-PTT)
W89-06168

MANGROVE AND SEAGRASS BEDS OF EAST ASIA: HABITATS UNDER STRESS,
Philippines Univ., Diliman, Quezon City. Marine Science Inst.
M. D. Fortes.
Ambio AMBOCX, Vol. 17, No. 3, p 207-213, 1988. 1 fig, 1 tab, 38 ref.

Descriptors: *Wetlands, *Coastal marshes, *Mangrove swamps, *Sea grasses, *Environmental effects, *East Asia, Resources management, Land use, Regional development, Water resources development, Wildlife habitats, Environmental protection, Coastal waters, Fisheries.

Mangrove and seagrasses show similar global patterns of generic richness, characterized by a maximum variety in the Indo-West Pacific where the countries of East Asia are situated. Unfortunately, these ecosystems are being destroyed by both natural and human-induced stresses. Natural stresses to the vegetation take the form of tropical cyclones, typhoons, tidal waves, volcanic activity, pests and diseases, and population interactions. On the other hand, man-induced stresses comprise the uncontrolled exploitation by traditional users and destructive activities unrelated to sustainable uses of the resources. Mangrove and seagrass coastal ecosystems are intricately linked by physical and nutrient interactions, animal migrations, and human impact. These habitat interconnections remain a key factor in the management of mangrove and seagrass resources in the East Asian region. The East Asian Seas Action Plan (EASAP) of the United Nations Environment Program helps to manage the marine environment and protection of coastal areas where the mangrove swamps and sea grasses are under stress. In July 1987 a regional project formulated for the EASAP was aimed at the rehabilitation of coastal fisheries areas using sea grass restoration technology. (Author's abstract)
W89-06172

GRAZING EFFECTS ON STREAM HABITAT AND FISHES: RESEARCH DESIGN CONSIDERATIONS,
Rocky Mountain Forest and Range Experiment Station, Tempe, AZ. Forestry Sciences Lab.
For primary bibliographic entry see Field 4C.
W89-06288

ESTIMATION OF PRODUCTION FORGONE,
Michigan Univ., Ann Arbor. School of Natural Resources.
A. L. Jensen, R. H. Reider, and W. P. Kovalak.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 2, p 191-198, Spring 1988. 2 fig, 3 tab, 12 ref, 3 append.

Descriptors: *Ecological effects, *Productivity, *Biomass, *Population dynamics, *Fish populations, *Estimating, Powerplants, Comparison studies, Sensitivity analysis, Lake Erie.

Production forgone is the biomass that would have been produced by fish killed by an environmental disturbance, such as a power plant might induce, if they had not been killed and had been subject to the same growth and mortality as fish not killed. Three methods for estimating production forgone were compared by assessing the effects of powerplant entrainment and impingement on gizzard shad Dorosoma cepedianum in western Lake Erie. The three approaches evaluated were (1) the Rago method, which is a direct method based on exponential mortality and growth; (2) a continuous-time direct method based on exponential mortality and the von Bertalanffy growth equation; and (3) an indirect method, based on exponential mortality and the von Bertalanffy growth equation, in which production forgone was calculated as the difference between population production with and without an environmental disturbance. An initial estimate of production forgone by the direct approach of Rago, which does not require an estimate of recruitment, can be used to estimate recruitment for the indirect estimate of production forgone; together, the direct and indirect approaches give a more-complete assessment of production forgone. A sensitivity analysis showed production forgone was sensitive to changes in mortality rates of larvae, young of the year, and juveniles and to change in the asymptotic weight of adults. (Shidler-PTT)
W89-06290

EFFECTS OF HYDROLOGICAL CHANGE AND THE CESSATION OF STOCKING ON A STREAM POPULATION OF SALMO TRUTTA L.,
Tasmanian Inland Fisheries Commission, Hobart (Australia).
P. E. Davies, R. D. Sloane, and J. Andrew.
Australian Journal of Marine and Freshwater Research AJMFA4, Vol. 39, No. 3, p 337-354, 1988. 11 fig, 4 tab, 42 ref.

Descriptors: *Fish populations, *Trout, *Fish stocking, *Stream fisheries, *Fish, *Australia, Fish management, Hydrologic aspects, Streamflow, River flow, Population dynamics.

The North Esk-St. Patricks river system, northern Tasmania, was electrofished at 27 sites in 1985, 30 years after the same sites had been electrofished in a previous study on the survival of released brown trout. All sites were dominated by brown trout, Salmo trutta L. Stocking of brown trout fry and yearlings ceased after 1956 and few releases were made in 1985. At all but 4 sites, the number and total biomass of brown trout were higher in 1985 than in 1955. The estimated total population of brown trout had increased by 63%, accompanied by a 55% increase in the number of fish of legal size (> 22 cm). Previously described 'nursery streams' still maintained high densities of 0+ fish, despite considerable changes in the age composition at other sites. Change in year-class strength was highly correlated with change in total annual river flow in the natal year. This is explained in terms of mortality in 'nursery streams' during periods of low river flow. Four sites where major changes in riparian habitat occurred exhibited decreased brown trout biomass but still showed changes in age structure due to variation in annual flow. Mean annual river flow had increased by three times since the 1950s and the effects of changes in river hydrology on the trout population are discussed. Growth of S. trutta was essentially independent of density. The number of anglers, total effort and the total harvest in 1985/86-1986/87 were significantly higher than in 1945/46-1953/54. A shift toward higher catch per season per angler was observed in 1985/86-1986/87 compared to the 1945/46-1953/54 seasons, but catch per day had not changed. Total annual mortality remained at 70%. (Author's abstract)
W89-06329

WORMS, WELLS AND WATER IN WESTERN MADAGASCAR,
Southampton Univ. (England).
S. E. Howarth, J. M. Wilson, E. Ranaivoson, S. E. Crook, and A. M. Denning.
Journal of Tropical Medicine and Hygiene JTMHA9, Vol. 91, No. 5, p 255-264, October 1988. 1 fig, 6 tab, 16 ref.

Descriptors: *Water pollution effects, *Path of pollutants, *Parasites, *Madagascar, *Worms, *Schistosomiasis, *Epidemiology, *Irrigation effects, *Wells, *Sanitation, *Public health, Diseases, Shallow wells, Irrigation ditches, Snails, Drainage, Water table, Feces, Molluslicides, Groundwater pollution.

A study of schistosomiasis and intestinal parasites was carried out on 496 children in the Ankilivalo District of western Madagascar. In two schools within the area of a major irrigation scheme the prevalence of urinary schistosomiasis was 60%; 50% of the children harbored at least one intestinal worm. Only 7% of children outside the main irrigation area tested positive for schistosomiasis. In the irrigation area the prevalence of parasites was greater than recorded in 1971 (13%), before the irrigation system was completed. As a result of irrigation, the water table has risen, providing many small channels and pools suitable for the snail intermediate host for schistosomiasis. Although the domestic well water supply is plentiful and kept reasonably clean and well drained, sanitation is primitive. Taboos that govern defecation prevent widespread use of latrines, and feces are commonly found near houses. Remedial measures to reduce the prevalence of water-borne disease include drainage improvements, landfilling, improved nutrition, additional shallow well construction, lining wells with oil drums, and the use of molluscicides in bathing places. (Cassar-PTT)
W89-06333

BELUGA WHALE ECOLOGY: A CONCERN OF FRESHWATER BIOLOGISTS,
Institute of Arctic Ecophysiology, Churchill (Manitoba).
For primary bibliographic entry see Field 2L.
W89-06446

BREATHING LIFE BACK INTO A DROWNED RESOURCE: MITIGATING WILDLIFE LOSSES IN THE COLUMBIA BASIN UNDER THE NORTHWEST POWER ACT,
For primary bibliographic entry see Field 6E.
W89-06595

CULTURAL RESOURCE INVESTIGATION AND ASSESSMENT OF PREHISTORIC SITE 450K7, OKANOGAN COUNTY, WASHINGTON,
Eastern Washington Univ., Cheney. Archaeological and Historical Services.
R. A. Masten.
Short Report SR-162, 1988. 26p, 2 fig, 3 tab, 9 ref, 2 append.

Descriptors: *Environmental impact, *Washington, *Archaeology, History, Social aspects, Water resources development.

Investigations undertaken in April 1988, were intended to assess the nature and extent of remaining portions of prehistoric site 450K7, but the work was stopped at the request of the allottee before all necessary data could be obtained. Auger testing revealed that the remaining area of occupation encompasses approximately 6,325 sq m. Both subsurface testing and surface inspections revealed that a substantial area of the site remains intact. Although it is not known that percentage of the actual or original area of occupation this locale represents, the estimated volume totals about 6,175.9 cu m. The quantity and range of artifact types and the presence of several features identified from the investigations also suggests that significant deposits still exist within the identified site area. (Lantz-PTT)
W89-06625

ARCHAEOLOGICAL SURVEY OF BRONCO JIM POINT (10PR2477), AMERICAN FALLS RESERVOIR, SOUTHEASTERN IDAHO.
Idaho Museum of Natural History, Pocatello.
S. E. Wright, and R. N. Holmer.
Reports of Investigations: 87-10, 1987. 35p, 8 fig, 10 tab, 13 ref, 2 append.

Descriptors: *Environmental impacts, *Archaeology, *Idaho, American Falls Reservoir, Bronco Jim Point, History, Social aspects, Water resources development, Trenches, Monitoring.

Survey of the Bronco Jim Point locality resulted in the location of a large number of fire-cracked rock features exposed in deflated sands. Other cultural resources, including debitage, tools and faunal remains were associated with these features, but in general, were quite rare. Test excavations also revealed little in cultural materials, but verified the extremely mobile nature of the sediment on the windward side of the prominent central dunal ridge in the project area, and the more stabilized deposits on the leeward side. Though surface exposures in highly deflated contexts dominated, the in situ Feature 19 hearth exposed in Test Excavation A points to the possibility of subsurface manifestations in this locality in a relatively undisturbed state. However, because surface exposures at the site represent extensive aeolian-derived disturbance processes, the research potential of these surface features is minimal. This potential might by pursued by a test trenching or test excavation program in the area, perhaps guided by means of resistivity surveying to detect subsurface anomalies in the dominantly sand/silt matrix. It is further recommended that any ground disturbances along the present access road or in other areas on the lee side also be carefully monitored by an archaeologist as work progresses. (Lantz-PTT)

W89-06626

DECAYING LAKES: THE ORIGINS AND CONTROL OF CULTURAL EUTROPHICATION,
For primary bibliographic entry see Field 5G.
W89-06629

7. RESOURCES DATA

7A. Network Design

INITIAL ATTEMPT TO OPTIMIZE THE OPERATION OF A HYDROMETRIC NETWORK USING BRANCH AND BOUND ALGORITHM,
Environment Canada, Winnipeg (Manitoba). Water Resources Branch.
P. M. Pelletier, and S. P. Simonovic.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 4, p 717-725, August 1988. 4 fig, 5 tab, 19 ref.

Descriptors: *Networks, *Network design, *Data Acquisition, *Model studies, *Hydrologic data, *Algorithms, *Optimization, Canada, Mathematical models, Streamflow, Sediment discharge, Cost analysis, Manitoba, Gaging stations, Traveltime, Computer models.

A new approach developed to formulate and solve the problem of field operation of a hydrometric network for discharge, water level, and sediment measurements is presented. The hydrometric technician travels between approximately 20 stations in Manitoba, Canada, over the period of a week. The problem exists to determine the optimal route to operate a network of hydrometric gauges within a given area. If the route is optimal, the cost to operate the network will be reduced. Optimization techniques are not used in the present practice. Instead, a traveling salesman problem (TSP) algorithm is used to find the optimal solution to the traveling hydrometric technician problem. For the Dauphin hydrometric field area in Manitoba, an optimal solution has been obtained using the TSP algorithm based on assumptions of where the technician can stay overnight, the average time allowed to service and perform the appropriate work at a discharge station, the average vehicle speed driven by the technician, the number of hours to be worked per day, and the time alloted for the return trip to the central station. Conclusions were drawn about future research directions incorporating development of an effective heuristic algorithm for solving the traveling hydrometric technician problem. (Geiger-PTT)
W89-05830

HYDROLOGIC SAMPLING: A CHARACTERIZATION IN TERMS OF RAINFALL AND BASIN PROPERTIES,
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
R. L. Bras, D. G. Tarboton, and C. Puente.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 113-135, September 30, 1988. 9 fig, 5 tab, 16 ref. USGS Grant 14-08-0001-G1143 and NSF Grant ECE-8513556.

Descriptors: *Rainfall-runoff relationships, *Storm runoff, *Rainfall, *Flood hydrographs, *Hydrologic models, *Sampling, *Network design, Errors, Estimating, Linear variation, Storms.

Sampling of rainfall and discharge processes in time and space are considered and the sampling problem is linked to basin and rainfall characteristics. The effectiveness of different sampling strategies is measured by the variance of the error in estimating either total or peak of streamflow from a single storm event. This is related to the rainfall and basin rainfall-discharge properties through parameterizations of these processes. Rainfall was modeled as a collection of rain cells which occur randomly in space and time and had parameters which define the probability of occurrence of rain cells in space and time and the spread of rainfall due to a cell. Parameters were assigned to discharge from rainfall in terms of the fluvial geomorphology of the basin. Linear filtering techniques are used to compute the variance of the estimation error for different sampling strategies. Sampling strategies are defined by the number of rain gages, rainfall sampling interval, and discharge measurement interval. The results can be used in hydrologic network design to assess the effectiveness of different sampling options. (Author's abstract)
W89-05846

TESTING A LIMESTONE AQUIFER USING WATER-TABLE RESPONSE TO STORM WATER DISCHARGED INTO SINKHOLES,
TRC Environmental Consultants, Inc., Somerset, NJ.
For primary bibliographic entry see Field 2F.
W89-05879

APPLICATION OF KRIGING TO RAINFALL NETWORK DESIGN,
Pittsburgh Univ., PA.
U. M. Shamsi, R. G. Quimpo, and G. N. Yoganarasimhan.
Nordic Hydrology NOHYBB, Vol. 19, No. 3, p 137-152, 1988. 8 fig, 8 tab, 13 ref.

Descriptors: *Model studies, *Rainfall, *Mathematical models, *Rain gages, *Network design, *Kriging, Watersheds, Statistics, Data acquisition, Hydrologic data, Water resources data.

Universal kriging techniques based on the based on the generalized covariances corresponding to IRF-k (intrinsic random function of order k) theory, are applied to analyze the design of rain-gaging networks in regions where the spatial mean is not constant. The objective is to obtain an optimal estimate of watershed precipitation. For the purpose of analysis symmetric asymmetric hypothetical rainfall fields are considered. The hypothesized storms provide the bases for comparing the results of the analysis. The results are also compared with traditional approaches in current use. The investigation depicts the superiority of kriging techniques over the other methods. The effect of storm spatial variability on the network design is also examined. (Author's abstract)
W89-05900

ESTIMATES OF MEAN CHLOROPHYLL-A CONCENTRATION: PRECISION, ACCURACY, AND SAMPLING DESIGN,
McGill Univ., Montreal (Quebec). Dept. of Biology.
For primary bibliographic entry see Field 7B.
W89-06058

EFFECT OF SAMPLE SIZE ON PARAMETER ESTIMATES IN SOLUTE-TRANSPORT EXPERIMENTS,
Agricultural Research Service, New Orleans, LA. Southern Regional Research Center.
For primary bibliographic entry see Field 2G.
W89-06483

LOGNORMAL KRIGING FOR THE ASSESSMENT OF RELIABILITY IN GROUNDWATER QUALITY CONTROL OBSERVATION NETWORKS,
Universidad Politecnica de Cataluna, Barcelona (Spain).
L. Candela, R. A. Olea, and E. Custodio.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 67-84, November 15, 1988. 13 fig, 2 tab, 16 ref.

Descriptors: *Kriging, *Groundwater management, *Water quality control, *Sampling, *Network design, Distribution, Observation wells, Aquifers, Error analysis, Saline water intrusion, Confined aquifers, Barcelona, Spain, Chlorides, Tracers, Statistical methods.

Groundwater quality observation networks are examples of discontinuous sampling on variables presenting spatial continuity and highly skewed frequency distributions. Anywhere in the aquifer, lognormal kriging provides estimates of the variable being sampled and a standard error of the estimate. The average and the maximum standard error within the network can be used to improve dynamically the network sampling efficiency or find a design able to assure a given reliability level. The approach does not require the formulation of any physical model for the aquifer or any actual sampling of hypothetical configurations. A case study is presented using the network monitoring salty water intrusion into the Llobregat delta confined aquifer, Barcelona, Spain. The variable chloride concentration used to trace the intrusion exhibits sudden changes within short distances which make the standard error fairly invariable to changes in sampling pattern and to substantial fluctuations in the number of wells. (Author's abstract)
W89-06512

GEOSTATISTICAL SCHEMES FOR GROUNDWATER SAMPLING,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
S. Rouhani, and T. J. Hall.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 85-102, November 15, 1988. 12 fig, 1 tab, 13 ref. NSF grant ECE-8503897; US DOI, Geological Survey project G-1219(05).

Descriptors: *Geostatistical methods, *Groundwater quality, *Statistical methods, *Sampling, *Network design, *Monitoring, Planning, Water quality control, Dougherty Plain, Georgia, Aquifers, Groundwater pollution, Statistical analysis, Leakage.

Geostatistical techniques offer efficient tools for design of groundwater sampling networks. They include procedures for the selection of the best sequences of sampling points, such as: variance reduction analysis, median ranking, and risk ranking. Variance reduction analysis considers primarily the accuracy of the estimated field, while median ranking is based only on the magnitude of the estimated values. Risk ranking is a compromise between these procedures that appears to yield a more balanced guideline for cases when planners desire to acquire maximum information, while monitoring areas where the variable of interest exhibits critical values. These procedures were used for the design of a regional shallow groundwater quality monitoring network in the Dougherty Plain, located in southwest Georgia. The shallow aquifer of concern is the main recharge route to a semiconfined aquifer which is the primary source of water in this region. The desired monitoring network acts as an early warning system for groundwater pollution in deeper layers. Leakance data were utilized to identify the primary sampling locations. Statistical analyses indicated that leakance has a log-normal distribution with a constant drift and a linear spatial covariance. The results of the risk rankings demonstrate that the southern tip of the Dougherty Plain and its upper central zone should be the prime targets of our monitoring activities. (Author's abstract)
W89-06513

VARIOGRAPHIC EXPERIMENT: AN ESSENTIAL TEST FOR OPTIMIZING SAMPLING METHODOLOGY IN MONITORING STREAMS,
Gy (Pierre) and Pitard (Francis) Sampling Consultants, Broomfield, CO.
F. F. Pitard.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 44-58, 8 fig, 8 ref.

Descriptors: *Network design, *Sampling, *Optimization, *Monitoring, *Wastewater analysis, *Statistical methods, Bias, Errors, Variographic experiment, Water analysis, Sediments, Spoil banks, Pollutant identification.

Systematic and random sampling (stratified or not) are applied widely to monitor toxic chemicals in streams, municipal wastes, sediments, dredge spoils, and so on. One advantage of systematic sampling is the simplicity of identifying exact sampling points. However, it can lead to biased results.

The advantage of simple random and stratified random sampling is the expectation that results will be unbiased; it is difficult to identify exact sampling points, however. The primary attraction of systematic sampling is that, if no cyclic phenomenon is present, it can produce unbiased results with better precision than is possible with simple random or stratified random sampling. A test is described that provides an answer to the difficult choice of selecting the most appropriate sampling methodology for a particular case. The distribution of toxic chemicals in a number of sites in an autocorrelated function of space or time most of the time. The study of this function provides an effective means of deciding how many increments a sample should contain, how often an increment should be taken, and how the increment should be collected to maintain representativeness when cyclic phenomena occur. The test provides essential information on the sampling selection error by separating this error into three major components. The first component is a short-range quality fluctuation error, which includes errors introduced by small local composition and distribution heterogeneities. The second component is a long-range quality fluctuation error, which represents the continuous trend introduced by the waste producer. The third component is a periodic fluctuation error, which may render systematic sampling a difficult and risky operation. Systematically implementing a variographic experiment on sites where a long-term commitment for monitoring is essential is recommended. Not only does it effectively optimize the sampling methodology, but it also gives valuable information on the variability of the parameter of interest, which in turn give valuable clues to the waste producer in solving his problem. (See also W89-06705) (Author's abstract)
W89-06712

COST EFFECTIVENESS OF THE U.S. GEOLOGICAL SURVEY STREAM-GAGING PROGRAM IN ALABAMA,
Geological Survey, Tuscaloosa, AL. Water Resources Div.
For primary bibliographic entry see Field 6C.
W89-06836

WATER-DATA PROGRAM OF THE U.S. GEOLOGICAL SURVEY IN KANSAS, FISCAL YEAR 1983,
Geological Survey, Lawrence, KS. Water Resources Div.
R. K. Livingston, and K. D. Medina.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 84-4306, (1984). 33p, 11 fig, 4 tab, 20 ref.

Descriptors: *Network design, *Water resources data, *Hydrologic data, *Data acquisition, *Project planning, *Kansas, Management planning, Groundwater, Lakes, Rivers, Reservoirs, Hydrologic systems.

The U.S. Geological Survey is the principal Federal agency cooperating with State agencies in the collection of hydrologic data needed for the planning, development, use, and management of the water resources in Kansas. Hydrologic data collection by the U.S. Geological Survey in Kansas began in 1895. The fiscal-year 1983 water data program, operated in cooperation with several Federal, State, and local agencies, included 278 stations for collection of river, lake, and reservoir data; 1,940 wells for collection of groundwater data; and 58 sampling stations and 215 wells for collection of water quality data. This report provides a detailed description of the water data program, including coordination and funding, data collection activities, quality assurance plans, availability of data, network design, and future needs for water data. (Author's abstract)
W89-06867

OPTIMAL SCHEMES FOR GROUNDWATER QUALITY MONITORING IN THE SHALLOW AQUIFER, DOUGHERTY PLAIN, SOUTHWESTERN GEORGIA,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5B.
W89-06896

GROUNDWATER CONTAMINATION ASSESSMENTS,
Oklahoma State Univ., Stillwater. Graduate Coll.
J. F. Kelly.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8701036. Ph.D. Dissertation, 1986. 408p, 123 fig, 23 tab, 131 ref, 3 append.

Descriptors: *Network design, *Data collections, *Groundwater pollution, *Mathematical models, *Model studies, Data interpretation, Case studies, Groundwater movement, Groundwater runoff.

Groundwater contamination assessments were evaluated based on the need for high quality data, an understanding of the limitations of existing theories of groundwater and contaminant behavior, and the interplay between technical and sociopolitical factors in the decision making process. Field methods for characterizing natural process parameters are still relatively crude and there remains an unwarranted perception that mathematical models can always back out the important parameters. Decision-makers are reluctant to fund the use of state of the art technologies that might avoid abuses of such models. The cost effectiveness of conventional and state of the art approaches to characterizing and remediating groundwater contamination problems needs to be evaluated in terms of overall costs in the long term, not up-front costs in the short term. It is neither necessary nor appropriate to try to solve most groundwater contamination problems with the most sophisticated mathematical models available. The lack of adequate field tests to characterize natural processes affecting contaminant transport, together with the inherent variability of chemical data, make rigorous model calibration efforts extremely difficult. (Cremmins-AEPCO)
W89-06927

DEMAND FOR WATER RESOURCES INFORMATION: A CONCEPTUAL FRAMEWORK AND EMPIRICAL INVESTIGATION,
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Agricultural Economics.
For primary bibliographic entry see Field 6A.
W89-06964

7B. Data Acquisition

EVALUATION OF SEVERAL SELECTIVE MEDIA FOR RECOVERY OF AEROMONAS HYDROPHILA FROM POLLUTED WATERS,
Malaga Univ. (Spain). Dept. of Microbiology.
For primary bibliographic entry see Field 5A.
W89-05796

DESIGN AND USE OF A HYDRAULIC POTENTIOMANOMETER FOR DIRECT MEASUREMENT OF DIFFERENCES IN HYDRAULIC HEAD BETWEEN GROUNDWATER AND SURFACE WATER,
Geological Survey, Lakewood, CO.
T. C. Winter, J. W. LaBaugh, and D. O. Rosenberry.
Limnology and Oceanography LIOCAH, Vol. 33, No. 5, p 1209-1214, September 1988. 3 fig, 16 ref.

Descriptors: *Measuring instruments, *Instrumentation, *Pressure head, *Surface-groundwater relations, *Manometers, *Potentiometers, *Pressure-measuring instruments, Seepage, Hydraulic properties, Groundwater movement, Fluid mechanics, Hydraulics, Groundwater, Surface water, Sand, Sediments, Sampling, Solute transport.

A hydraulic potentiomanometer is described that consists of a potentiometer connected to a manometer by a flexible tube. The device is used to measure directly the direction of seepage as well as the hydraulic-head difference between groundwater and surface water. Detailed drawings of the design and step-by-step instructions for its use are presented. The device is a modified combination of a manometer-and-probe and piezometer tip. The probe consists of two hollow stainless-steel rods of different diameters such that one slides inside the other. The inner rod is the actual potentiometer. The outer rod protects the piezometer screen and prevents it from becoming plugged by fine-grained material. The device works best in sandy materials, and can also be used to sample groundwater for chemical analysis. Suggestions are given for resolving common problems such as air leaks. (Doria-PTT)
W89-05808

DIRECT VIABLE COUNTING METHOD FOR MEASURING TOLERANCE OF AQUATIC MICROBIAL COMMUNITIES TO HG(2+),
Technology Applications, Inc., Gulf Breeze, FL.
C. Liebert, and T. Barkay.
Canadian Journal of Microbiology CJMIAZ, Vol. 34, No. 9, p 1090-1095, September 1988. 3 fig, 1 tab, 27 ref.

Descriptors: *Tolerance, *Bioindicators, *Mercury, *Toxicity, *Aquatic bacteria, *Bacterial physiology, *Water pollution effects, *Microbiological studies, Microscopy, Bacteria, Heterotrophic bacteria, Escherichia coli, Isotope studies, Growth media, Growth, Environment, Aquatic environment, Estuarine environment.

Direct counts of Hg(2+)-resistant cells in natural waters were obtained by fluorescence microscopy after incubation for 20 h in the presence of a growth substrate, nalidixic acid to halt cell division, and inhibiting concentrations of Hg(2+). This method discriminated Hg(2+)-resistant from Hg(2+)-sensitive Escherichia coli strains. Estuarine samples were used to compare this procedure with two other toxicity measurements that determine the effect of Hg(2+) on colony growth and on rates of radioactive thymidine incorporation into cellular material. Toxicity measurements based on direct viable counts and thymidine incorporation rates had comparable sensitivities, and both were 3-4 orders of magnitude more sensitive than the method that utilized colony counts. Thus, the direct enumeration of Hg(2+)-resistant cells is useful for predicting the potential of aquatic communities to sustain heterotrophic activity, an essential microbial process, in the presence of Hg(2+). (Author's abstract)
W89-05814

FLOOD DEPTH-DAMAGE CURVES BY INTERVIEW SURVEY,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05817

RESEARCH TOWARD AN OPERATIONAL PASSIVE MICROWAVE REMOTE SENSING SYSTEM FOR SOIL MOISTURE,
Agricultural Research Service, Beltsville, MD.
T. J. Jackson.
Journal of Hydrology JHYDA7, Vol. 102, No. 1-4, p 95-112, September 30, 1988. 7 fig, 1 tab, 33 ref.

Descriptors: *Remote sensing, *Soil water, *Microwaves, Sensors, Satellite technology, Vegetation, Temporal variation, Spatial variation.

The primary physical property of the Earth that affects the measurements obtained by a passive microwave sensor operating at 20-cm wavelength is the amount of water present in its field of view. Microwave sensors also have all-weather capability and can even observe soil moisture conditions under moderate levels of vegetation cover. When implemented on a high-altitude platform, passive microwave sensors can provide temporal and spatial observations of surface soil moisture. These capabilities are complementary with hydrologic forecasting and water management. A review of the current understanding of passive microwave remote sensing of soil moisture and examples of potential applications are presented including large

area mapping of soil moisture and temporal observations and modelling. Considerable research still needs to be done in the field of vegetation research, primarily plant structure. Also, more emphasis is being placed on active and passive microwave data collection in order to increase the possible information which can be obtained. (Rochester-PTT)
W89-05845

EVAPORATION FROM LAKE BIWA,
Kyoto Univ. (Japan). Disaster Prevention Research Inst.
For primary bibliographic entry see Field 2D.
W89-05862

TIME DOMAIN ELECTROMAGNETIC SOUNDINGS FOR MAPPING SEA-WATER INTRUSION IN MONTEREY COUNTY, CALIFORNIA.
Monterey County Food Control and Water Conservation District, Salinas, CA.
T. Mills, P. Hoekstra, M. Blohm, and L. Evans.
Ground Water GRWAAR, Vol. 26, No. 6, p 771-782, November-December 1988. 21 fig, 19 ref.

Descriptors: *Subsurface mapping, *Electrical studies, *California, *Coastal aquifers, *Seawater, *Saline water intrusion, Seawater intrusion, Impaired water quality, Agriculture, Geophysics, Conductivity, Chlorides, Water quality, Saline-freshwater interfaces, Sounding, Observation wells, Calibrations, Correlation analysis, Field tests, Hydrologic data collections.

In November 1986, a surface geophysical survey was performed in Monterey County, California using Time Domain Electromagnetic (TDEM) soundings. Previously, water quality samples were taken from monitoring wells to determine the extent of sea-water intrusion in the Salinas Valley. Of the 3 aquifers in the study area, 2 aquifers, the 180-ft and 400-ft, had been intruded. The third aquifer, the 900-ft aquifer, had not shown signs of sea-water intrusion. The District decided to use surface geophysics to obtain information about water quality between monitoring wells and to contour the position of the 500-ppm isochlor in both of the upper aquifers. Because the conductivity of water increases with chloride concentration, electrical methods are well-suited for mapping chloride concentration in groundwater. The TDEM sounding method was selected as the surface electrical measurement technique. It had proven successful for mapping interfaces between fresh water and salt water on surveys in Cape Cod, Massachusetts, in several areas in Florida, and in southern California. A total of 100 soundings were measured in the project area. These were located by using the information available from monitoring wells. Lines of soundings were run approximately perpendicular to the anticipated position of the 500-ppm isochlor to better define the location of the isochlor. By correlating the surface geophysics to water quality data from monitoring wells, the position of the 500-ppm isochlor could be mapped in both the 180-ft and 400-ft aquifer. The positions of the contours of the 500-ppm isochlor derived from monitoring wells and from 100 TDEM soundings show excellent agreement. There is more local detail in the isochlor contours derived from geophysical interpretations than in the contours derived from monitoring wells, mainly because of the higher TDEM station density. (Author's abstract)
W89-05881

WEIGHING LYSIMETER IN A REGENERATING EUCALYPT FOREST: DESIGN, CONSTRUCTION, AND PERFORMANCE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia).
W. Reyenga, F. X. Dunin, B. C. Bautovich, C. R. Rath, and L. B. Hulse.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 301-314, October-December 1988. 8 fig, 11 ref.

Descriptors: *Lysimeters, *Forest hydrology, *Evaporation, *Water use, *Eucalyptus forests, Australia, Performance evaluation, Design criteria.

A 36 ton monolithic weighing lysimeter (3.7 m diameter and 1.5 m deep) was installed in Kioloa State Forest near Batemans Bay, New South Wales, Australia, to provide a continuous record of water use from a regenerating natural eucalypt community, 5 years old at installation. The resolution is equivalent to 0.05 mm of evaporation. The sensitivity of 14 ppm compares favorably with those reported for other lysimeters, similar in magnitude, in the U.S.A. Design criteria for selecting, isolating and suspending a sample community in situ with an electro-mechanical balance to minimize disturbance and to avert possible changes in character of the isolated natural community. Lysimeter performance was assessed both in terms of its accuracy and its operation as a remote facility with infrequent attention. (See also W89-05887) (Author's abstract)
W89-05886

ANALYSIS OF VOLATILE ORGANIC COMPOUNDS IN WATER BY DYNAMIC STRIPPING, THERMAL DESORPTION, CRYOFOCUSING, AND CAPILLARY GAS CHROMATOGRAPHY,
Northrop Services, Inc., Ada, OK.
For primary bibliographic entry see Field 5A.
W89-05945

SPECTROPHOTOMETRIC CATALYTIC DETERMINATION OF AN ULTRATRACE AMOUNT OF IRON(III) IN WATER BASED ON THE OXIDATION OF N,N-DIMETHYL-P-PHENYLENEDIAMINE BY HYDROGEN PEROXIDE,
Nihon Univ., Tokyo. Dept. of Industrial Chemistry.
For primary bibliographic entry see Field 5A.
W89-05950

ELECTRON MICROSCOPY OF NANOMETER PARTICLES IN FRESHWATER,
Nagoya Univ. (Japan). Faculty of Engineering.
For primary bibliographic entry see Field 2K.
W89-05952

DEVELOPMENT OF BIOLOGICAL WATER QUALITY ASSESSMENT IN THE NETHERLANDS,
Limburg Water Pollution Control Authority, Roermond (Netherlands).
For primary bibliographic entry see Field 5G.
W89-05988

DETERMINATION OF ESTUARINE DIFFUSION COEFFICIENTS USING A FLUOROMETRIC DYE TRACING TECHNIQUE,
Heriot-Watt Univ., Edinburgh (Scotland). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2L.
W89-05993

NEAR SURFACE SOIL MOISTURE ESTIMATION FROM MICROWAVE MEASUREMENTS,
Institut National de la Recherche Agronomique, Montfavet (France). Station de Science du Sol.
L. Bruckler, H. Witono, and P. Stengel.
Remote Sensing of the Environment RSEEA7, Vol. 26, p 101-121, November 1988. 11 fig, 4 tab, 17 ref.

Descriptors: *Soil water, *Measuring instruments, *Microwaves, *Soil analysis, Statistical analysis, Backscattering, Estimating, Regression analysis, Loam, Clay, Volumetric analysis, Soil water potential.

Soil moisture, water potential and bulk density measurements were performed on a 0.4 ha bare field (27.2% clay, 61.7% fine and coarse loam) concurrent with backscattering coefficient measurements. Seventeen different volumetric water content profiles from 0 to 10 cm were sampled including wet, intermediate and dry conditions. Backscattering coefficients were measured using a 4.5 GHz frequency, HH polarization and 15 to 20 degree incidence angle microwave sensor configuration, in order to minimize the soil surface roughness effects. First, the statistical analysis of the data (classical calibration procedure) exhibited satisfactory regression lines between the backscattering coefficient and the volumetric water content calculated over arbitrary soil depths, as described by many authors (correlation coefficients between 0.859 and 0.899). Furthermore, the same results were obtained when water potential data were considered (log scale). Second, taking into account the dependence between the water content profile and the microwave penetration depth, the experimental relationship between backscattering coefficient and volumetric water content became nonlinear and exhibited smaller residuals than the classical regression line. Finally, a statistical procedure for predicting the mean and standard deviation of volumetric water content profiles from the surface to the microwave penetration depth is presented. Results showed that the proposed procedure is promising for obtaining near-surface water content estimates used as boundary conditions for soil/atmosphere water transport modeling. (Author's abstract)
W89-06010

IDENTIFICATION OF OIL SPILLED AT SEA BY HIGH PERFORMANCE GEL PERMEATION CHROMATOGRAPHY PATTERN RECOGNITION,
Government Industrial Research Inst., Osaka, Ikeda (Japan).
For primary bibliographic entry see Field 5A.
W89-06020

USE OF IN SITU MICROCOSMS FOR EVALUATING RESERVOIR WATER MANAGEMENT OPTIONS,
Nevada Univ. System, Las Vegas. Water Resources Center.
R. H. French, J. J. Cooper, and S. Vigg.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1007-1015, October 1988. 2 tab, 6 fig, 18 ref.
EPA Assistance Agreement R811124-02-0.

Descriptors: *Microcosms, *In situ tests, *Reservoir operation, *Water quality management, *Lake restoration, Eutrophication, Phytoplankton, Nutrient removal, Nutrient requirements, Nevada, Nitrogen, Phosphorus, Phosphorus removal.

The use of in situ microcosms for performing reservoir trophic studies and aiding in the design of reservoir restoration programs are discussed. The site of this study was Lahontan Reservoir, Nevada, which has experienced water quality problems associated with monospecific blooms of blue-green algae and hypolimnetic dissolved oxygen depletions. In situ microcosms were used to investigate the response of phytoplankton species composition to additions of the nutrients nitrogen, phosphorus, and the phosphorus precipitant aluminum sulfate. At the end of the 16-day experimental period, the microcosms receiving the phosphate treatments yielded the highest standing crops of algae and the greatest percentage composition of blue-green algae. The microcosms receiving the nitrate treatment exhibited greater initial algal concentrations followed by a decline in photoplankton, which coincided with an increase in the zooplankton population. The results presented here suggest that microcosms can be a cost-effective method for assessing reservoir water quality and planning restoration programs. (Author's abstract)
W89-06056

ESTIMATES OF MEAN CHLOROPHYLL-A CONCENTRATION: PRECISION, ACCURACY, AND SAMPLING DESIGN,
McGill Univ., Montreal (Quebec). Dept. of Biology.
C. T. Marshall, A. Morin, and R. H. Peters.
Water Resources Bulletin WARBAQ, Vol. 24, No. 5, p 1027-1034, October 1988. 4 fig, 3 tab, 48 ref, append.

Descriptors: *Water sampling, *Lakes, *Chlorophyll a, *Reservoirs, Estimating, Estimating equa-

tions, Trophic level, Hydrologic models, Precision, Variation coefficient, Water quality.

Data from 56 north-temperate lakes and reservoirs were used to develop models predicting temporal variance as a function of the mean chlorophyll-a concentration. Trophy, as estimated by mean chlorophyll-a concentration, had little effect on the sampling effort required to achieve a pre-determined level of precision for lakes sampled year-round. Collecting ten observations results in a coefficient of variation that averaged 20%; collecting more than ten observations yields increasingly marginal improvements in precision. The same guidelines apply to mesotrophic or eutrophic lakes sampled in the summer, whereas oligotrophic lakes sampled in the summer require fewer observations to achieve the same level of precision. The bias resulting from collecting too few observations is minimized if five or more observations are collected. (Author's abstract)
W89-06058

MEASURING THE SPATIAL VARIABILITY OF SOIL HYDRAULIC CONDUCTIVITY USING AN AUTOMATIC NEUTRON MOISTURE GAUGE,
CEA Centre d'Etudes Nucleaires de Cadarache, Saint-Paul-les-Durance (France).
For primary bibliographic entry see Field 2G.
W89-06068

COMPARISON OF PERCOLATION TEST RESULTS AND ESTIMATED HYDRAULIC CONDUCTIVITIES FOR MOLLISOLS AND ALFISOLS,
Illinois Univ. at Urbana-Champaign. Dept. of Agronomy.
For primary bibliographic entry see Field 2G.
W89-06085

EXPERIMENTAL STATION FOR THE AUTOMATIC RECORDING OF WATER AND SEDIMENT DISCHARGE IN A SMALL ALPINE WATERSHED,
Padua Univ. (Italy). Dept. of Land and Agro-Forest Environment.
S. Fattorelli, M. Lenzi, L. Marchi, and H. M. Keller.
Hydrological Sciences Journal HSJODN, Vol. 33, No. 6, p 607-617, December 1988. 6 fig, 1 tab, 5 ref.

Descriptors: *Telemetry, *Sediment discharge, *Alpine regions, *Erosion, *Data acquisition, *Sediment transport, *Sampling, Italian Alps, Mountains, Hydrology, Watersheds, Bed load, Suspended load, Floods, Water level, Sediment concentration, Sensors, Remote sensing, Water quality.

Rating sediment transport contributes greatly to an improved knowledge of the relationships between hydrological and sediment transport processes. In alpine watersheds, the importance of these processes is not matched by a corresponding amount of available field data on sediment transport and particularly on bed load. Detailed measurements made in experimental watersheds can help collect data on sediment transport in small mountain streams. In this connection, a small watershed (5 sq km) in the Italian Alps strongly affected by erosion has been equipped with an experimental station for recording water and sediment discharge data. The experimental station operates chiefly on the separation of bedload from suspended load. The two fractions are measured by different devices. The experimental equipment has been derived with different objectives: to record sediment transport data under different hydrological conditions including flood events; to provide reliable input data for deterministic erosion models; and to test different methodologies for water sampling, water level measurement, and suspended sediment concentration measurement. The station is also equipped with sensors for gathering water quality parameters, and with a device for the automatic sampling of discharge water. A detailed description of the experimental equipment and of the data recorded by the station is given. (Author's abstract)
W89-06091

BICARBONATE ESTIMATION FROM ALKALINITY DETERMINATIONS FOR NEUTRAL TO ACIDIC LOW ALKALINITY NATURAL WATERS: THEORETICAL CONSIDERATIONS,
Institute of Hydrology, Wallingford (England).
C. Neal.
Hydrological Sciences Journal HSJODN, Vol. 33, No. 6, p 619-623, December 1988. 2 fig, 15 ref.

Descriptors: *Aluminum, *Toxicity, *Inorganic carbon, *Bicarbonates, *Alkalinity, *Acid rain, *Acidity, *Carbonates, Carbon cycle, Water quality, Chemical reactions, Equilibrium, Chemistry, Chemical properties, Carbonic acid, Soil chemistry, Acidic water, Alkaline water, Estimating equations, Land use, Water chemistry.

In most acidic environments susceptible to the impacts of acidic deposition and land-use change, the inorganic carbon system is extremely important in regulating streamwater acidity and aluminum toxicity. Characterization of the inorganic carbon system is therefore essential in describing temporal variability in stream water quality and, when used in conjunction with predictive models, in producing industrial emission and land-use strategies to minimize environmental impacts. An important prerequisite to such exercises is the accurate determination of H2CO3 and bicarbonate concentrations in soil, stream, and groundwaters and soil-air CO2 concentrations in acid-sensitive catchments. Unfortunately, such a prerequisite has not been adequately satisfied because CO2 and H2CO3 concentration measurements have been made infrequently while most environmental studies of acid-sensitive catchments have determined alkalinities with the consequence that bicarbonate concentrations have had to be assessed indirectly from these values. In this technical note, the link between alkalinity and bicarbonate concentrations is examined. Errors in the various approximations being made to assess bicarbonate concentration from alkalinity measurements are determined from a theoretical standpoint for waters of concern in these environmental studies. (Doria-PTT)
W89-06092

RELATIONSHIP BETWEEN CONCENTRATION AND SENSORY PROPERTIES OF 2-METHYLISOBORNEOL AND GEOSMIN IN DRINKING WATER,
Osaka Prefecture Water Works Bureau (Japan). Water Testing Station.
For primary bibliographic entry see Field 5A.
W89-06102

CHEMICAL ECOLOGY AND OFF-FLAVOUR SUBSTANCES,
Norsk Inst. for Vannforskning, Oslo.
O. M. Skulberg.
Water Science and Technology WSTED4, Vol. 20, No. 8/9, p 167-178, 1988. 3 fig, 47 ref.

Descriptors: *Physiological ecology, *Taste, *Water quality, *Water pollution effects, *Organic compounds, *Water pollution sources, Organoleptic properties, Biochemistry, Metabolism, Reviews, Seasonal variation, Plankton, Carbon cycle, Eutrophication, Algae, Sulfur compounds, Fish migration.

Off-flavor substances may be regarded as a resource which can be used to study special ecological mechanisms. Relevant research on off-flavors is inextricably combined with the study of perception, ethology, genetic control, etc. The chemicals concerned are commonly perceived by the senses of olfaction and gustation. Thus, research on the chemical ecology of off-flavor substances in the aquatic environment involves the study of a variety of disciplines. For example, the biochemistry of the relevant substances and appropriate metabolic pathways must be considered. Chemical properties are important for the behavior of the substances. The production of off-flavors by organisms is related to phenological circumstances. The biotic effects of ecologically significant substances are dependent on several environmental factors. This paper draws attention to the possible application of fundamental research in this area to selected problems of ecological importance. (Author's abstract)
W89-06123

DETECTION OF PLANKTONIC CYANOBACTERIA BY TANDEM IN VIVO FLUOROMETRY,
Wisconsin Dept. of Natural Resources, Madison. Bureau of Research.
C. J. Watras, and A. L. Baker.
Hydrobiologia HYDRB8, Vol. 169, No. 1, p 77-84, November 10, 1988. 6 fig, 2 tab, 26 ref. EPA Cooperative agreement CR810961-01.

Descriptors: *Fluorometry, *Water analysis, *Chlorophyll, *Chlorophyta, *Phytoplankton, *Cyanobacteria, *Fluorescence, Hydrologic data collections, Chlorophyll a, Assays, Mapping, Spatial distribution, Temporal distribution, Bioindicators, Lakes, Spectrophotometry, Remote sensing.

For freshwater cyanobacteria, the autofluorescence of phycocyanin is quite high while the in vivo fluoresence (IVF) yield of chlorophyll-a is relatively low, apparently because of low chlorophyll concentrations associated with photosystem II. In eucaryotic phytoplankton, even those with phycobiliprotein accessory pigments (e.g. some cryptophytes), the opposite is true. Thus, an IVF ratio which relates phycocyanin to chlorophyll-a signals could be a good index of relative cyanobacterial abundance in the field. Spectrofluorometric scans of whole cells from laboratory cultures indicated that the ratio of phycocyanin to chlorophyll-a fluorescence Em660-Ex630/Em680-Ex430 could be a very sensitive cyanobacterial indicator. Tandem flowthrough fluorometers were then fitted with the appropriate interference filters and their discriminatory power was evaluated with mixtures of cyanobacterial and eucaryotic phytoplankton. Although subject to many of the constraints of other IVF assays, tandem fluorometry should be particularly appropriate for real-time mapping of the relative spatial and temporal distributions of broad phytoplankton taxa in continuous vertical or horizontal profiles in lakes. (Author's abstract)
W89-06155

DETERMINATION OF AQUITARD/AQUICLUDE HYDRAULIC PROPERTIES FROM ARBITRARY WATER-LEVEL FLUCTUATIONS BY DECONVOLUTION,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W89-06206

METHOD FOR INSTALLING AND MONITORING PIEZOMETERS IN BEDS OF SURFACE WATERS,
Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
S. J. Welch, and D. R. Lee.
Ground Water GRWAAR, Vol. 27, No. 1, p 87-90, January-February 1989. 4 fig, 3 ref.

Descriptors: *Data acquisition, *Piezometers, Water level, Field tests, Bottom sediments, Surface-groundwater relations, Lakes.

A method has been tested for manually driving piezometers into the bottom sediments of surface water bodies. It allows piezometers to be driven from a floating platform. After installation a flexible piezometer line remains that does not pose a safety hazard at the water surface. The piezometer line may be attached to a float on the water surface or may be extended to the shoreline, enabling measurement of hydraulic head and geochemical sampling. Piezometers have been installed successfully in 6-8 m of water, 40 m offshore and 2-2.5 m below the sediment surface in medium- to fine-grained sand. Construction, coring and installation, and use of these piezometers is described and illustrated. (Author's abstract)
W89-06208

DOSING SYSTEM TO VARY PH, SALINITY, AND TEMPERATURE,

Maryland Univ., Baltimore. School of Medicine.
For primary bibliographic entry see Field 5A.
W89-06232

INTEGRATED DISTRIBUTION MANAGEMENT SYSTEMS,
Wessex Water Authority, Bristol (England).
For primary bibliographic entry see Field 5F.
W89-06238

UNCERTAINTIES IN THE SINGLE DETERMINATION OF RIVER DISCHARGE: A LITERATURE REVIEW,
Environment Canada, Winnipeg (Manitoba). Water Resources Branch.
For primary bibliographic entry see Field 2E.
W89-06244

INTERPRETATION OF FIELD TRACER TESTS OF A SINGLE FRACTURE USING A TRANSIENT SOLUTE STORAGE MODEL,
National Hydrology Research Inst., Ottawa (Ontario).
K. G. Raven, K. S. Novakowski, and P. A. Lapcevic.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2019-2032, December 1988. 4 tab, 11 fig, 60 ref.

Descriptors: *Aquifer testing, *Pumping tests, *Path of pollutants, *Geohydrology, *Geologic fractures, *Groundwater movement, *Fracture permeability, Model studies, Deterministic models, Tracers, Radioactive tracers, Dye releases, Induced-gradient tracer tests, Boreholes, Advection-dispersion models, Transient solute storage models.

The prospect of storage and disposal of radioactive and toxic chemical wastes in fractured low-permeability geologic media requires the quantifying of transport processes to be able to predict solute migration in fracture-controlled groundwater flow systems. Five induced-gradient tracer tests were performed at five different average interborehole fluid velocities in a single fracture in monzonitic gneiss. The experiments were conducted using radioactive Br82 and a fluorescent dye as conservative tracers where the tracers were pulse injected into radial convergent and injection-withdrawal flow fields. The tracer breakthrough curves were determined from samples of the withdrawn groundwater and were interpreted using residence time distribution (RTD) theory and two deterministic simulation models. The RTD curves of the tracer experiments were interpreted by fitting to the field data a simple advection-dispersion model and an advection-dispersion model with transient solute storage in immobile fluid zones. Comparison of the fits obtained by the simulation models suggest that the initial period of solute transport in single fractures is advection dominated and with increasing tracer residence time or decreasing fluid velocity, transport progresses toward more Fickian-like behavior. During the advective-dominated period, the transient solute storage model is shown to describe adequately the asymmetries and long tails characteristic of the fracture residence time distribution. Interpretation of the tracer experiments using both simulation models further suggests that induced-gradient tracer experiments are likely to underestimate the dispersive characteristics of single fractures under natural flow conditions. (Author's abstract)
W89-06258

FLOW AND TRACER TRANSPORT IN A SINGLE FRACTURE: A STOCHASTIC MODEL AND ITS RELATION TO SOME FIELD OBSERVATIONS,
Royal Inst. of Tech., Stockholm (Sweden). Dept. of Chemical Engineering.
L. Moreno, Y. W. Tsang, C. F. Tsang, F. V. Hale, and I. Neretnieks.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2033-2048, December 1988. 3 tab, 16 fig, 37 ref. DOE contract DE-AC03-76SF00098.

Descriptors: *Aquifer testing, *Pumping tests, *Path of pollutants, *Stochastic models, *Groundwater movement, *Fracture permeability, *Tracers, *Solute transport, Flow characteristics, Flow pattern, Model Studies, Particle tracking.

Calculations for the flow and solute transport through a single rough-surfaced fracture were carried out. The fracture plane was discretized into a square mesh to which variable apertures were assigned. The spatially varying apertures of each single fracture were generated using geostatistical methods, based on a given aperture probability density distribution and a specified spatial correlation length. Calculations showed that fluid flow occurs predominantly in a few preferred paths. Hence, the large range of apertures in the single fracture gives rise to flow channeling. The solute transport was calculated using a particle tracking method. The spatial variation of tracer transport between a line of injection points and a line of observation points are displayed in contour plots which were labeled 'transfer matrix'. The results indicate that such plots can give information on the spatial correlation length of the heterogeneity in the fracture. The tracer break-through curve obtained from a line of point measurements is shown to be controlled by the aperture density distribution and is insensitive to statistical realization and spatial correlation length. These results suggest the importance of making line measurements in the laboratory and the field. (Author's abstract)
W89-06259

CALCITE-CARBON EQUILIBRIUM IN SOIL WATER SAMPLES,
Technische Univ. Muenchen (Germany, F.R.). Lehrstuhl fuer Hydrogeologie und Hydrochemie.
J. Grossmann, B. Merkel, and P. Udluft.
Zeitschrift fuer Wasser- und Abwasser-Forschung ZWABAQ, Vol. 21, No. 5, p 177-181, October 1988. 5 fig, 4 tab, 16 ref.

Descriptors: *Sampling, *Sample preservation, *Soil water, *Calcite, *Carbon, *Soil gases, *Chemical precipitation, Literature review, Equilibrium, Hydrogen ion concentration.

During soil-water sampling with suction cups, a degassing of the sample occurs which is caused by the vacuum in the sampling system. This degassing results in both an increase of the pH value and a supersaturation of the sample with calcite. Measurements and calculations show that no calcite is precipitated, since the critical saturation index of 1.0 to 1.2 is usually not reached in soil-water sampling systems. Several methods are described in the literature for obtaining soil-water samples without degassing. Laboratory experiments, however, prove that degassing is not the only reason for the alteration of the pH value; microbiological activities also appear to affect the samples. (Author's abstract)
W89-06282

POTENTIOSTATIC METHOD FOR THE SENSITIVE MEASUREMENT OF THE CHEMICAL OXYGEN DEMAND (COD) (EIN POTENTIOSTATISCHES VERFAHREN ZUR EMPFINDLICHEN BESTIMMUNG DES CHEMISCHEN SAUERSTOFFBEDARFS (CSB)),
Entwicklungsgesellschaft fuer Umwelttechnik m.b.H., Berlin (Germany, F.R.). Laser and Analytical Research.
For primary bibliographic entry see Field 5A.
W89-06287

SEPARATION AND SIZE CHARACTERIZATION OF COLLOIDAL PARTICLES IN RIVER WATER BY SEDIMENTATION FIELD-FLOW FRACTIONATION,
Chisholm Inst. of Tech., Melbourne (Australia). Water Studies Centre.
For primary bibliographic entry see Field 2J.
W89-06301

COMPARISON OF CYTOPATHOGENICITY, IMMUNOFLUORESCENCE IN IN SITU DNA HYBRIDIZATION AS METHODS FOR THE DETECTION OF ADENOVIRUSES,
Health Effects Research Lab., Cincinnati, OH.
For primary bibliographic entry see Field 5A.
W89-06302

INFLUENCE OF GROWTH MEDIUM COMPOSITION ON THE TOXICITY OF CHEMICALS TO ALGAE,
Lancashire Polytechnic, Preston (England).
L. A. Millington, K. H. Goulding, and N. Adams.
Water Research WATRAG, Vol. 22, No. 12, p 1593-1597, December 1988. 2 fig, 3 tab, 13 ref.

Descriptors: *Algae, *Environmental impact, *Growth media, Chlorophyta, *Toxicity, Organic compounds, Growth rates, Selenastrum, Scenedesmus, Chlorella, Sensitivity, Nutrients.

Algal growth inhibition tests are an important part of monitoring programs designed to predict the environmental impact of new substances. This study investigated the effects of varying growth medium composition on the toxicity of four chemicals (morpholine, nitrilotriacetic acid, o-dichlorobenzene and triphenyl phosphate) to three species of freshwater green algae recommended for use in standard algal growth inhibition tests: Selenastrum capricornutum, Scenedesmus subspicatus and Chlorella vulgaris. Bold's basal, OECD and EPA media were used. The toxic values obtained from the tests suggest that medium composition significantly affected the sensitivity of the test algae to the four chemicals, but not in a predictable fashion. (Author's abstract)
W89-06308

SIMPLE AND INEXPENSIVE METHOD FOR DETERMINING STREAM DISCHARGE FROM A STREAMBANK,
New York State Museum, Albany.
D. P. Molloy, and R. H. Struble.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 477-481, December 1988. 1 fig, 1 tab, 6 ref. NIH Grant AI-15605.

Descriptors: *Stream gaging, *Gaging, *Discharge measurement, *Stream discharge, *Flow discharge, *Field tests, Stream banks, Flotation, Flow rates, Measuring instruments.

A detailed protocol for the determination of stream discharge is presented which requires neither a current meter nor actual entry into streamwater. The protocol represents a modification of the flotation method of discharge determination and was devised in response to the need for a simple,inexpensive, 'bank-side' technique for estimation of stream flow. Discharge is determined through measurements of a stream's cross-sectional area and surface velocity. In tests at high and low flows, mean discharges determined by the proposed flotation method were not significantly different from those calculated using a standardized, current-meter method. This suggested that the proposed flotation method (a 10-20 min procedure) could be used with reasonable accuracy to determine discharge in small to moderate-sized streams. (Author's abstract)
W89-06320

MODIFIED MPN METHOD FOR COUNTING OLIGOTROPHIC BACTERIA BY USING NATURALLY OCCURRING ORGANICS,
Kyoto Univ. (Japan). Dept. of Fisheries.
For primary bibliographic entry see Field 2H.
W89-06371

MODEL TO QUANTIFY WASTEWATER ODOR STRENGTH,
National Univ. of Singapore. Dept. of Civil Engineering.
L. C. C. Koe, and N. C. Tan.
Water, Air, and Soil Pollution WAPLAC, Vol. 39, No. 3/4, p 303-309, June 1988. 4 fig, 2 tab, 12 ref.

Descriptors: *Odors, *Sludge, *Wastewater treatment, *Mathematical models, Chemical strength, Odor strength, Digested sludge.

A method of quantifying the odor strength of wastewater samples has been investigated. Wastewater samples from two locations of a wastewater treatment plant were collected and subjected to air stripping. The off-gas odor concentration was measured by a dynamic olfactometer at various time intervals. Applying a first order model to the decay of odorous substances in the wastewater under air stripping, the initial odor strength of the wastewater was determined. The model was acceptable under five different air-stripping rates studied. (0.005, 0.010, 0.015, 0.j020, and 0.030 cu m/min). A digested sludge had a higher odor strength of 868,030 sou/cu m compared to that of a thickened sludge at 465,800 sou/cu m. (Brock-PTT)
W89-06389

ANALYTICAL PROCEDURE FOR THE MEASUREMENT OF ATP EXTRACTED FROM ACTIVATED SLUDGE,
Institut National de la Recherche Scientifique, Sainte-Foy (Quebec).
Y. Lefebvre, P. Couture, and D. Couillard.
Canadian Journal of Microbiology CJMIAZ, Vol. 34, No. 11, p 1275-1279, November 1988. 3 tab, 1 fig, 27 ref. FCAR grant AS-2462.

Descriptors: *Wastewater analysis, *Water analysis, *Activated sludge process, *Activated sludge, *Wastewater treatment, *Adenosine triphosphate, Extraction techniques, Biomass, Laboratory studies, Biochemical tests.

There have been numerous attempts to link the ATP content of activated sludge to certain wastewater characteristics or to certain control parameters used in the operation of wastewater treatment plants. The development of an analytical method that requires filtration on polycarbonate membrane (0.4 micrometers) and a subsequent ATP extraction with DMSO is discussed. The filtration step overcomes problems of enzymatic inhibition in the firefly bioluminescence assay due to dissolved substances in the liquid fraction of the activated sludge samples. In comparison with extraction in boiling TRIS buffer, the most widely used method, extraction in DMSO was found to be effective and advantageous owing to its simplicity and reliability, the ease of its execution, and its potential use in routine measurements. The application of this analytical procedure to aerobic sludges in batch culture yielded a higher estimate of the average value of the ATP pool than previously published results. (Author's abstract)
W89-06414

TILE DRAIN SAMPLING OF PREFERENTIAL FLOW ON A FIELD SCALE,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
T. L. Richard, and T. S. Steenhuis.
Journal of Contaminant Hydrology JCOHE6, Vol. 3, No. 2-4, p 307-325, December 1988. 7 fig, 1 tab, 33 ref.

Descriptors: *Path of pollutants, *Soilwater, *Solute transport, *Tile drains, *Tracers, Chlorides, Rainfall, Soil porosity, Sampling, Flow pattern, Preferential flow.

Preferential flow phenomena generally exhibit a high degree of spatial variability. In an alternative to geostatistical approaches, which aggregate many small-scale sample results, tile drains were explored as a means to measure solute movement on a scale which integrates spatial variability within the sampling volume. To evaluate the effectiveness of this method, a mass balance accounting of a conservative tracer, chloride, was attempted over a 7-month period. Analysis of the drain effluent indicated rapid breakthrough of surface-applied chloride, with concentrations rising within 4 hours of rainfall initiation. This travel time was over two orders of magnitude more rapid than that predicted by homogeneous flow models, indicating the importance of preferential flow in the transport of solutes through this field. Close agreement between the amount of chloride initially applied and the cumulative chloride recovered by the end of the experiment indicates the ability of tile drains to intercept solute movement. (Author's abstract)
W89-06432

HANDY IMPACT CORER FOR SAMPLING LAKE SURFACE SEDIMENT,
National Inst. for Environmental Studies, Ibaraki (Japan).
K. Satake.
Hydrobiologia HYDRB8, Vol. 169, No. 3, p 259-264, November 30, 1988. 4 fig, 8 ref.

Descriptors: *Cores, *Samplers, *Impact corers, *Sediment samplers, *Lake sediments, Bottom sampling, Bottom sediments.

A handy impact corer for sampling of surface sediments (<50 cm) in lakes is described. The coring apparatus consists of a sample tube, tube holder, stopper, stopper holder, shaft with wing, shaft holder, hammer, and pushing rod. The total weights are 3.8 kg (Type I: 2.3 cm inside diameter of the tube) and 6.7 kg (Type II: 5.5 cm inside diameter of the tube). The system enables confirmation of the vertical landing of the corer onto the lake bottom and effective entering of sediment into the sample tube using the hammer, and prevention of falling out of the core using the stopper and pushing rod. (Author's abstract)
W89-06436

SPATIAL DEPENDENCE OF THE RELATIONSHIP BETWEEN RAINFALL AND OUTGOING LONGWAVE RADIATION IN THE TROPICAL ATLANTIC,
Maryland Univ., College Park. Dept. of Meteorology.
J. M. Yoo, and J. A. Carton.
Journal of Climate JLCLEL, Vol. 1, No. 10, p 1047-1054, October 1988. 5 fig, 1 tab, 24 ref. NSF Grant OCE-86-10422.

Descriptors: *Remote sensing, *Climatology, *Rainfall, *Satellite technology, *Radiation, *Weather data collections, Tropical regions, Spatial distribution, Atlantic Ocean, Wind, Salinity.

A spatially dependent formula was developed to estimate rainfall from satellite-derived outgoing longwave radiation (OLR) data and the height of the base of the trade-wind inversion. This formula was constructed by comparing rainfall records from twelve islands in the tropical Atlantic with 11 years of OLR data. Zonal asymmetries due to the differing cloud types in the eastern and western Atlantic and the presence of Saharan sand in the east are included. The climatological winter and summer rainfall derived from the above formula concurs with ship observations described by Dorman and Bourke. However, during the spring and fall, OLR-derived rainfall is higher than observations by 2-4 mm/day in the intertropical convergence zone. The largest discrepancy occurs during the fall in the region west of 28 degrees W. Interannual anomalies of rainfall computed using this technique are large enough to cause potentially important changes in ocean surface salinity. (Author's abstract)
W89-06468

SAMPLING ERROR STUDY FOR RAINFALL ESTIMATE BY SATELLITE USING A STOCHASTIC MODEL,
Texas A and M Univ., College Station. Coll. of Geosciences.
K. S. Shin, and G. R. North.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 11, p 1218-1231, November 1988. 11 fig, 1 tab, 16 ref, 2 append. NASA Grant GSFC 5-1503.

Descriptors: *Stochastic Models, *Remote sensing, *Satellite technology, *Rainfall, Mathematical models, *Error analysis, Time series analysis, Markov process, Precipitation rate, Sampling, Hydrologic data collections, Remote sensing, Estimating.

A parameter study of satellite orbits was performed to estimate sampling errors of area-time averaged rain rate due to temporal sampling by satellites. The sampling characteristics were investigated by accounting for varying visiting intervals and varying fractions of averaging area on each visit as a function of the latitude of the grid box for a range of satellite orbital parameters. The sampling errors were estimated by a simple model based on the first-order Markov process of the time series of area averaged rain rates. For a satellite of nominal TRMM orbit (30 degrees inclination and 300 km altitude) carrying an ideal scanning microwave radiometer for direct precipitation measurements, sampling error would be about 8 to 12% of estimated monthly mean rain rates over a grid box of 5 degrees by 5 degrees. The effect of uneven sampling intervals with latitude tend to be offset by increasing sampling areas with latitude, therefore, the latitude dependence of sampling error was not important. Nomograms for sampling errors are presented for a range of orbital parameters centered at nominal TRMM orbit. An observation system based upon the low inclination satellite combined with a sunsynchronous satellite simultaneously would be especially promising for precipitation measurements from space. Sampling errors well below 10% can be achieved for this idealized system case for the monthly rain rate estimates for 5 degrees by 5 degrees boxes. (Author's abstract)
W89-06479

SINGLE THRESHOLDING AND RAIN AREA DELINEATION FROM SATELLITE IMAGERY,
Wisconsin Univ.-Milwaukee. Dept. of Geosciences.
A. A. Tsonis.
Journal of Applied Meteorology JAMOAX, Vol. 27, No. 11, p 1302-1306, November 1988. 2 fig, 12 ref.

Descriptors: *Remote sensing, *Satellite technology, *Precipitation, *Meteorological data collection, *Rainfall area, *Rainfall distribution, Remote sensing, Comparison studies, Infrared imagery.

The use of simple methods of assessing rainfall area from satellite imagery is compared with more sophisticated methods. A thresholding technique which delineates the rain area by using a single threshold from a single image (visible or infrared) was used to estimate rainfall in the midlatitudes at a spatial resolution of 4 by 4 km. The accuracy of the estimation was determined by comparison with more elaborate techniques that used ground verification radar data. Results showed that, in general, very little accuracy was lost using the simple technique. The simpler method is less expensive over large space and time frames, and may be more easily adapted to different climatological areas. It is suggested that accuracy requirements be critically addressed and investigated before a scheme is employed. (Geiger-PTT)
W89-06480

SOIL COLUMN DESCRIPTIONS FROM X-RAY COMPUTED TOMOGRAPHY DENSITY IMAGES,
Norges Landbrukshoegskole, Aas. Inst. for Georesources and Pollution Research.
P. D. Jenssen, and P. H. Heyerdahl.
Soil Science SOSCAK, Vol. 146, No. 2, p 102-107, August 1988. 4 fig, 11 ref.

Descriptors: *X-rays, *Bulk density, *Soil density, *Tomography, Soil compaction, Soil porosity, Soil columns, Computers, Measuring instruments.

Conventional methods for measuring soil bulk density do not allow the observation of three-dimensional density distribution in a nondestructive manner. X-ray tomography, or computer-assisted tomography (CT), was originally developed for medical purposes, but offers the possibility of studying other matter within the density range of human body components. CT was applied to the study of packing arrangement and density of soil columns used in experiments concerning water transport and wastewater purification. Results show that CT is a valuable tool in describing column experiments. CT has elucidated the packing procedure for soil columns, factors of impor-

tance for water flow, and has reduced uncertainties about the experimental conditions. The information obtained by CT is essential for making comparisons with other experiments and has initiated vital improvements in column construction. (Author's abstract)
W89-06482

TRITIUM AND HELIUM ISOTOPES AS HYDROLOGIC TRACERS IN A SHALLOW UNCONFINED AQUIFER,
Scripps Institution of Oceanography, La Jolla, CA.
R. J. Poreda, T. E. Cerling, and D. K. Salomon.
Journal of Hydrology JHYDA7, Vol. 103, No. 1-2, p 1-9, November 15, 1988. 3 fig, 2 tab, 11 ref. NSF Grant EAR85-19320; DOE contract DE-AC05-84OR211400.

Descriptors: *Tracers, *Groundwater movement, *Radioactive dating, *Tritium, *Helium, *Isotopic tracers, *Geohydrology, Isotope studies, Saturation zone, Flow, Groundwater movement, Radioactive waste disposal, Hydraulic conductivity, Aquifers.

Measurements of tritium and He3 in groundwater can be used to calculate the age of tritium in groundwater. Such combined measurements on water samples thus provide a powerful tool towards understanding fluid flow in the near-surface saturated zone. Tritium and helium isotope measurements were performed on waters from an unconfined aquifer associated with a low-level nuclear waste storage area. These values were used to calculate ages of tritium in groundwater from 0.1 to 6 years. From the groundwater ages and a three-dimensional flow, net hydraulic conductivities of .0000033 to .0000055 m/s for five wells, and extreme values from a single well of .000018 and .000097 m/s, were calculated. These values agree with hydraulic conductivities obtained from conventional aquifer tests. The high conductivity value may indicate an area of preferred fluid flow. These preliminary results suggest that the tritium-helium isotope method may be useful for estimating residence times for waters in groundwater systems, in determining preferred pathways for fluid migration, and in estimating hydraulic conductivities on a different scale from conventional measurements. While these results are for a system with tritium input that are higher than the global average, this method should be applicable to most waters having measurable tritium because exceptionally high tritium levels are not a prerequisite for precise H3 or He3 measurements. (Author's abstract)
W89-06508

SATELLITE-OBSERVED CHARACTERISTICS OF MIDWEST SEVERE THUNDERSTORM ANVILS,
National Aeronautics and Space Administration, Greenbelt, MD. Goddard Space Flight Center.
For primary bibliographic entry see Field 2B.
W89-06541

DETERMINATION OF ZIRCONIUM AND HAFNIUM IN NATURAL WATERS BY ISOTOPE DILUTION MASS SPECTROMETRY,
Cambridge Univ. (England). Dept. of Earth Sciences.
S. M. Boswell, and H. Elderfield.
Marine Chemistry MRCHBD, Vol. 25, No. 3, p 197-209, November 1988. 2 fig, 5 tab, 18 ref. NERC Grant GR3/6010; NERC Research Studentship GT4/83/AAPS/10.

Descriptors: *Water analysis, *Rare earth elements, *Chemical analysis, *Zirconium, *Hafnium, *Heavy metals, *Mass spectrometry, Sample preparation, Geochemistry, Sampling, Reagents, Hydrochloric acid, Marine environment, Estuarine environment, Detection limits, Ion exchange, Chemical interference, Rivers.

A method for the determination of zirconium and hafnium in natural waters by means of isotope dilution mass spectrometry is presented. The extraction of the two elements from the sample is achieved by ferric hydroxide co-precipitation. This is followed by separation from other elements by a single cation exchange column, using HCl and HNO3 as eluents. Mass spectrometry is carried out using a single Re filament with the sample loaded in a mixture of HNO3 and colloidal carbon. The method has been used to determine Zr and Hf in a variety of samples, with concentrations covering the ranges of 80-2400 pmol/kg and 3-45 pmol/kg, respectively. These measurements indicate a large degree of fractionation between Zr and Hf in the marine environment, the Zr/Hf weight ratio dropping from around 40 in crustal rocks to around 5 in seawater. (Author's abstract)
W89-06543

APPROACH TO ESTIMATING HYDRAULIC CONDUCTIVITY SPATIAL CORRELATION SCALES USING GEOLOGICAL CHARACTERISTICS,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 2F.
W89-06589

NATIONAL SURFACE WATER SURVEY: EASTERN LAKE SURVEY (PHASE I--SYNOPTIC CHEMISTRY)--QUALITY ASSURANCE REPORT,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
M. D. Best, S. K. Drouse, L. W. Creelman, and D. J. Chaloud.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-133749. Price codes: A06 in paper copy, A01 in microfiche. Report No. EPA/600/4-86/011, December 1986. 180p, 9 fig, 28 tab, 32 ref, 5 append. EPA Contract No. 68-03-3050 and 68-03-3249.

Descriptors: *Quality assurance, *Synoptic analysis, *Surveys, *Lakes, *Water quality, *Water analysis, *Chemical analysis, Physical analysis, Statistical analysis, Data collections, Precision, Water sampling, Detection limits, Field tests, Quality control.

An overview of the quality assurance activities and results of the Eastern Lake Survey-Phase I quality assurance program, used a combination of blank, duplicate, and audit samples to provide an external check on the data quality of 32 physiochemical parameters measured and to allow early detection of problems in sample collection, processing, and analysis. Field sampling, field and analytical laboratory, and database quality control protocols also were standardized to ensure the reliability of the data. The survey results were verified to identify and to correct, qualify, or eliminate data of unacceptable quality. The verification process was based on known relationships between the physiochemical parameters. The quality of the data for 10 nonchemical parameters also was determined during the validation process. A final data set, which was generated from the validated data, was used for calculating population estimates. The statistical analysis of the verified data set included estimates of instrumental and system detection limits, system decision limits, overall and analytical within-batch precision, and overall and analytical among-batch precision. Quantification limits also were calculated for use in evaluating the precision of the survey data. The results of these statistical analyses were compared to the data quality objectives for detectability and for precision. (Author's abstract)
W89-06642

K-1407-B AND K-1407-C GROUNDWATER ASSESSMENT PLAN,
Oak Ridge Gaseous Diffusion Plant, TN.
For primary bibliographic entry see Field 5B.
W89-06644

NATIONAL SURFACE WATER SURVEY. NATIONAL STREAM SURVEY PHASE I. PILOT SURVEY--SUMMARY OF QUALITY ASSURANCE DATA RESULTS,
Lockheed Engineering and Management Services Co., Inc., Las Vegas, NV.
S. K. Drouse.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-140298. Price codes: A04 in paper copy, A01 in microfiche. Report No. EPA/600/8-37/057, December 1987. 45p, 9 fig, 13 tab, 8 ref. EPA Contract 68-03-3249.

Descriptors: *Quality assurance, *Acid rain, *Water quality, *Data acquisitions, *Quality control, *Water analysis, *Surveys, *Surface waters, Statistical analysis, Data interpretation, Streams, Detection limits, Sampling.

A primary objective of the National Surface Water Survey and, therefore of the National Stream Survey, is to ensure that the data collected are scientifically sound and of known quality. An extensive quality assurance program has been established in support of this objective. To evaluate the effectiveness of the quality assurance program, several types of quality assurance and quality control samples were collected and analyzed during a pilot survey that was conducted prior to the initiation of National Stream Survey Phase I field activities. This study was performed prior to the initiation of the full-scale NSS field activities as part of the National Surface Water Survey (NSWS), under the administration of the National Acid Precipitation Assessment Program. This report presents a statistical analysis of results obtained for field duplicate samples, blank samples, and audit samples used in the pilot survey. The results show that even overall estimated within-batch precision was adequate to meet the analytical data quality objectives established for the National Stream Survey and that detection limit goals were achieved at the contract analytical laboratories. The observed system decision limits and system detection limits, however, must be considered in interpreting the pilot study data and data from future surveys that employ similar sampling, processing, and analytical methods. (Author's abstract)
W89-06646

ESTABLISHING A LEVEL OF CONFIDENCE FOR THE ANALYTICAL VALUES FOR THE TRACE METALS IN THE LOS ALAMOS DRINKING WATER SUPPLY AND DISTRIBUTION SYSTEM,
For primary bibliographic entry see Field 5A.
W89-06648

STATISTICAL ANALYSIS OF GEOTECHNICAL DATA,
Nexus Associates, Wayland, MA.
For primary bibliographic entry see Field 7C.
W89-06651

SUMMARY REPORT FOR THE NATIONAL ATMOSPHERIC DEPOSITION PROGRAM/ NATIONAL TRENDS NETWORK (NADP/NTN) SITE VISITATION PROGRAM: FOR THE PERIOD DECEMBER, 1984 THROUGH SEPTEMBER, 1986,
Research Triangle Inst., Research Triangle Park, NC.
For primary bibliographic entry see Field 5B.
W89-06656

EVALUATION OF THE MAGNETIC INDUCTION CONDUCTIVITY METHOD FOR DETECTING FRAZIL ICE DEPOSITS,
Cold Regions Research and Engineering Lab., Hanover, NH.
S. A. Arcone, B. E. Brockett, D. E. Lawson, and E. F. Chacho.
Available from National Technical Information Service, Springfield, VA 22161, as AD-A186 940. Price codes: A03 in paper copy, A01 in microfiche. Report No. 87-17, September 1987. 12p, 6 fig, 13 ref, 2 append. Department of the Army Project 4A161102AT24.

Descriptors: *Measuring instruments, *Conductivity, *Monitoring, *Ice detection, *Frazil ice, Channels, Ice, Alaska, Tanana River, Cold regions, Mapping.

The ability to map frazil ice deposits and water channels beneath an ice-covered river in central Alaska using the magnetic induction conductivity (MI) technique was assessed. The study was performed during the first week of March 1986 on the Tanana River near Fairbanks and employed a commercially available instrument operating at a fixed frequency with a fixed antenna (coil) spacing and orientation. Comparisons of the MI data with theoretical models based upon physical data measured along three cross sections of the river demonstrate the sensitivity of the MI technique to frazil ice deposits. The conductivity generally derived for the frazil ice deposits encountered is very low (about 0.00063 S/m or microhms/m) when compared with the measured value for water (about 0.011 S/m), and is similar to the calculated values for gravel and sandy gravel bed sediments. In all three cross sections, maxima in the apparent conductivity profiles correlated with frazil ice deposits. Difficulties, possibly due to adverse effects of cold weather upon instrument calibration, affected the quantitative performance of the instrument on one cross section, although the interpretation of the data (locations of open channels vs. frazil deposits) was qualitatively unaffected. (Author's abstract)
W89-06673

DEMONSTRATION OF A UNIVERSAL KRIGING PROGRAM FOR MONITORING SEDIMENTS IN LAKES,
Environmental Monitoring and Support Lab.-Cincinnati, OH.
P. C. L. Lin, and J. F. Roesler.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 59-68, 6 fig, 1 tab, 4 ref.

Descriptors: *Network Design, *Kriging, *Computer programs, *Optimization, *Sampling, *Sediments, Statistical methods, Pollutant identification.

One among a large number of factors that must be considered in the initiation of a sediment, soil, and water sampling program is how to characterize the area sampled. This factor has two aspects: the project area and sampling locations. In this study, a universal kriging technique to select the optimized sampling location is presented. It is an optimization technique for interpolation and spatial averaging from sparse observation records. This method is applicable to any sampling problem when it uses observations of a random field at a number of points to obtain an estimate of the value of the field and the accuracy of the estimate at any point. It also restores the measured values as estimates at the data points, whereas other methods do not. An existing universal kriging program for the IBM-PC has been modified so that it not only estimates the value of the field and its variance at any location, but also draws contour maps. Using this information, the approximated maximum concentration of the field can be determined and sampling locations can be improved to yield more definitive data. (See also W89-06705) (Author's abstract)
W89-06713

BIODEGRADATION OF CHLORINATED AROMATIC CHEMICALS IN CONTINUOUS CULTURES,
Amsterdam Univ. (Netherlands). Lab. of Environmental and Toxicological Chemistry.
J. R. Parsons, D. T. Sijm, and M. C. Storms.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 206-214. 3 fig, 3 tab, 9 ref.

Descriptors: *Fate of pollutants, *Culturing techniques, *Chlorinated hydrocarbons, *Biodegradation, *Organic compounds, Polychlorinated biphenyls, Chemical analysis, Chemical properties.

Chemostat (continuous) cultures of microorganisms offer a number of advantages for the study of the biodegradation of xenobiotic chemicals compared to the more commonly used batch systems. Chemostat cultures enable the influence of environmental conditions and adaptation on biodegradation to be studied, as well as simplifying kinetic studies. The cometabolic degradation of chlorobiphenyls by a Pseudomonas strain in batch and chemostat cultures was compared. In batch cultures, there was ready degradation of mono- and dichlorobiphenyls, but not of tetrachlorobiphenyls. In contrast, tetrachlorobiphenyls were degraded in chemostat cultures exposed continuously to the compounds by means of a generator column. Degradation was apparently enhanced by the more favorable conditions in chemostat cultures, and not by adaptation of the bacteria. First order biodegradation rate constants for the tetrachlorobiphenyls were calculated from the steady-state concentrations in the cultures and the exposure concentrations. The rate constant for 2,2',3,3'-tetrachlorobiphenyl was much higher than those for the 2,2'5,5'- and 2,2',6,6'- isomers, suggesting that steric hindrance of 2,3-dioxygenation controls their degradation rates. (See also W89-06748) (Friedmann-PTT)
W89-06777

DAILY URBAN WATER USE ANALYSIS AND FORECASTING,
Texas Univ. at Austin. Graduate School.
For primary bibliographic entry see Field 6D.
W89-06975

7C. Evaluation, Processing and Publication

ADJUSTMENT FACTORS FOR FLOOD DAMAGE CURVES,
Waterloo Univ. (Ontario). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05818

SOME ALTERNATIVE APPROACHES TO MATHEMATICAL MODELLING OF RESERVOIR SYSTEMS,
Durban-Westville Univ. (South Africa).
For primary bibliographic entry see Field 4A.
W89-05836

EFFECTS OF SPATIAL VARIABILITY AND SCALE WITH IMPLICATIONS TO HYDROLOGIC MODELING,
Princeton Univ., NJ. Water Resources Program.
For primary bibliographic entry see Field 2E.
W89-05842

TECHNOLOGICAL DEVELOPMENTS IN REAL-TIME OPERATIONAL HYDROLOGIC FORECASTING IN THE UNITED STATES,
National Weather Service, Silver Spring, MD. Office of Hydrology.
For primary bibliographic entry see Field 2E.
W89-05844

INCORPORATION OF THE EFFECT OF CONCENTRATION OF FLOW INTO THE KINEMATIC WAVE EQUATIONS AND ITS APPLICATIONS TO RUNOFF SYSTEM LUMPING,
Kyoto Univ. (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05856

SEMIANALYTICAL COMPUTATION OF PATH LINES FOR FINITE-DIFFERENCE MODELS,
Geological Survey, Reston, VA. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-05878

NUMERICAL MIXING ZONE MODEL FOR WATER QUALITY ASSESSMENT IN NATURAL STREAMS: CONCEPTUAL DEVELOPMENT,
Cook Coll., New Brunswick, NJ. Dept. of Environmental Science.
For primary bibliographic entry see Field 5B.
W89-05884

SIMPLE WATER BALANCE DAILY RAINFALL-RUNOFF MODEL WITH APPLICATION TO THE TROPICAL MAGELA CREEK CATCHMENT,
Office of the Supervising Scientist for the Alligator Rivers Region, Sydney (Australia).
For primary bibliographic entry see Field 2E.
W89-05885

FIELD APPLICATION OF A NUMERICAL METHOD FOR THE DERIVATION OF BASEFLOW RECESSION CONSTANT,
Loughborough Univ. of Technology (England). Dept. of Civil Engineering.
M. D. Bako, and A. Owoade.
Hydrological Processes HYPRE3, Vol. 2, No. 4, p 331-336, October-December 1988. 1 fig, 3 tab, 4 ref.

Descriptors: *Model studies, *Recession, *Recession curve, *Streamflow forecasting, *Mathematical models, *Groundwater recharge, *Base flow, Base flow recession constant.

In an earlier paper, a method for the derivation of the baseflow recession constant (K) using one-way analysis of variance was presented. The results of the field application of this method are presented. The K values obtained by using the numerical equation previously obtained were inserted in the exponential recession equation to generate a series of baseflows. The fit between the model and the historical flows was greater than 99%, thus confirming the applicability of the numerical method under field situations. The main advantage of this technique is its amenability for computerized application, thus making it relatively faster than any of the existing techniques of fitting the recession equation. For this reason, the subjectivity inherent in most of the existing techniques is eliminated and a measure of procedural consistency can be guaranteed. Consistency is necessary if intercatchment comparison or interpolation of K values is to be meaningful. (Author's abstract)
W89-05888

PHYSICAL FRAMEWORK OF THE DEPENDENCE BETWEEN CHANNEL FLOW HYDROGRAPHS AND DRAINAGE NETWORK MORPHOMETRY,
Agricultural Research Service, Fort Collins, CO.
For primary bibliographic entry see Field 2E.
W89-05889

MODELLING LONG TERM STREAM ACIDIFICATION TRENDS IN UPLAND WALES AT PLYNLIMON,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W89-05890

MODELLING RAINFALL/WATERTABLE RELATIONS USING LINEAR RESPONSE FUNCTIONS,
Ministry of Agriculture, Fisheries and Food, Cambridge (England). Field Drainage Experimental Unit.
For primary bibliographic entry see Field 2B.
W89-05892

OVERLAND FLOW ON PERVIOUS, CONVERGING SURFACE,
Old Dominion Univ., Norfolk, VA. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-05901

ANALYSES OF 1-MIN RAIN RATES EXTRACTED FROM WEIGHING RAINGAGE RECORDINGS,
Air Force Geophysics Lab., Hanscom AFB, MA.

For primary bibliographic entry see Field 2B.
W89-05903

INFLUENCE OF LAND SURFACE ROUGHNESS ON ATMOSPHERIC CIRCULATION AND PRECIPITATION: A SENSITIVITY STUDY WITH A GENERAL CIRCULATION MODEL,
National Aeronautics and Space Administration, Greenbelt, MD. Lab. for Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W89-05904

IMPROVED GROUND HYDROLOGY CALCULATIONS FOR GLOBAL CLIMATE MODELS (GCMS): SOIL WATER MOVEMENT AND EVAPOTRANSPIRATION,
National Aeronautics and Space Administration, New York. Goddard Inst. for Space Studies.
For primary bibliographic entry see Field 2A.
W89-05921

HYDROLOGIC BALANCE MODEL USING NEUTRON PROBE DATA,
Oregon State Univ., Corvallis. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2G.
W89-05961

WEATHER INPUT FOR NONPOINT-SOURCE POLLUTION MODELS,
New York State Coll. of Agriculture and Life Sciences, Ithaca. Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 5B.
W89-05963

EXAMINATION OF 2-D GROUNDWATER RECHARGE SOLUTION,
Louisiana Tech Univ., Ruston. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-05964

DEFINING PHREATIC SURFACE FOR HETEROGENEOUS AQUIFERS,
Baghdad Univ. (Iraq). Coll. of Engineering.
For primary bibliographic entry see Field 2F.
W89-05966

MEAN CELL RESIDENCE TIME AND SLUDGE YIELD CALCULATIONS VIA PHOSPHORUS BALANCE,
Post, Buckley, Schuh and Jernigan, Inc., Orlando, FL.
For primary bibliographic entry see Field 5D.
W89-05974

VARIABLES INFLUENCING SULFIDE CONCENTRATION IN A GRAVITY FLOW COLLECTION SYSTEM,
Sybron Chemicals, Inc., Salem, VA.
For primary bibliographic entry see Field 5D.
W89-05976

MODELLING MICROBIAL PROCESSES (PHYTO- AND BACTERIOPLANKTON) IN THE SCHELDE ESTUARY,
Universite Libre de Bruxelles (Belgium). Groupe de Microbiologie des Milieux Aquatiques.
For primary bibliographic entry see Field 2L.
W89-05985

DEVELOPMENT OF A NEW SIMULATION METHOD FOR SUSPENDED SEDIMENT TRANSPORT IN A TIDAL RIVER,
Kyushu Univ., Fukuoka (Japan). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2J.
W89-06025

MODIFIED TIDAL PRISM MODEL FOR WATER QUALITY IN SMALL COASTAL EMBAYMENTS,
Virginia Inst. of Marine Science, Gloucester Point.
For primary bibliographic entry see Field 2L.
W89-06028

ROLE OF FINE SEDIMENT BEHAVIOUR IN POLLUTANT TRANSFER MODELLING,
Blackdown Consultants Ltd., Taunton (England).
For primary bibliographic entry see Field 2J.
W89-06032

WATER QUALITY MANAGEMENT OF THE HOOGHLY ESTUARY - A LINEAR PROGRAMMING MODEL,
Calcutta Metropolitan Development Authority (India).
For primary bibliographic entry see Field 5G.
W89-06039

ROLE OF ESTUARINE MODELING IN NUTRIENT CONTROL,
Virginia Univ., Charlottesville. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W89-06040

FIELD OBSERVATION AND SIMULATION OF SEDIMENT RESUSPENSION IN A SHALLOW LAKE,
National Inst. for Environmental Studies, Tsukuba (Japan). Water and Soil Environment Div.
For primary bibliographic entry see Field 2J.
W89-06042

DISPERSION MODELLING FOR A COMPLEX ESTUARY: THE CASE OF THE TAGUS,
Universidade Nova de Lisboa (Portugal). Environmental Systems Analysis Group.
For primary bibliographic entry see Field 5B.
W89-06043

ROLE OF MODELLING IN THE CONTROL OF SEAWATER POLLUTION,
Port and Harbour Research Inst., Yokosuka (Japan). Marine Hydrodynamics Div.
For primary bibliographic entry see Field 5G.
W89-06044

APPLICATION OF BASIN WIDE ECOLOGICAL MODELS (BAWEMS) TO THE FATE OF LAS IN TOKYO BAY,
Osaka Univ. (Japan). Dept. of Environmental Engineering.
For primary bibliographic entry see Field 5B.
W89-06045

STATISTICAL APPROACH TO ASSESS FACTORS AFFECTING WATER CHEMISTRY USING MONITORING DATA,
North Texas State Univ., Denton. Inst. of Applied Sciences.
For primary bibliographic entry see Field 5B.
W89-06057

DETERMINATION OF UNGAGED TRIBUTARY FLOWS AND INTERSEGMENTAL RESERVOIR FLOWS USING SPREADSHEET SOFTWARE,
Wisconsin Univ.-Platteville.
For primary bibliographic entry see Field 2E.
W89-06063

SHORT-TERM FORECASTING OF SNOWMELT RUNOFF USING ARMAX MODELS,
Williams (Philip) and Associates, San Francisco, CA.
For primary bibliographic entry see Field 2E.
W89-06065

NATIONWIDE REGRESSION MODELS FOR PREDICTING URBAN RUNOFF WATER QUALITY AT UNMONITORED SITES,
Geological Survey, Reston, VA.
For primary bibliographic entry see Field 5B.
W89-06066

ESTIMATING SPATIAL PATTERNS IN WATER CONTENT, MATRIC SUCTION, AND HYDRAULIC CONDUCTIVITY,
Washington State Univ., Pullman. Dept. of Agronomy and Soils.
For primary bibliographic entry see Field 2G.
W89-06072

MODEL FOR DEBRIS ACCUMULATION AND MOBILIZATION IN STEEP MOUNTAIN STREAMS,
British Columbia Univ., Vancouver. Dept. of Geography.
For primary bibliographic entry see Field 2J.
W89-06090

ODOROUS ALGAL CULTURES IN CULTURE COLLECTIONS,
Helsinki Univ. (Finland). Dept. of Limnology.
For primary bibliographic entry see Field 5B.
W89-06129

LAKE MIXIS AND INTERNAL PHOSPHORUS DYNAMICS,
Metropolitan Council, St. Paul, MN.
For primary bibliographic entry see Field 2H.
W89-06148

HYDRODYNAMIC AND OIL-SPILL MODELLING FOR THE EAST ASIAN SEAS REGION,
Chulalongkorn Univ., Bangkok (Thailand). Dept. of Marine Science.
For primary bibliographic entry see Field 5B.
W89-06170

MULTIVARIATE ANALYSIS IN HYDROCHEMISTRY: AN EXAMPLE OF THE USE OF FACTOR AND CORRESPONDENCE ANALYSES,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2K.
W89-06201

DETERMINATION OF AQUITARD/AQUICLUDE HYDRAULIC PROPERTIES FROM ARBITRARY WATER-LEVEL FLUCTUATIONS BY DECONVOLUTION,
Arizona Univ., Tucson. Dept. of Hydrology and Water Resources.
For primary bibliographic entry see Field 2F.
W89-06206

CONSEQUENCES OF THE MASS BALANCE SIMPLIFICATION IN MODELLING DEEP FILTRATION,
Krakow Technical Univ. (Poland). Faculty of Sanitary and Environmental Engineering.
For primary bibliographic entry see Field 5F.
W89-06217

MODELING OF RETENTION OF ORGANIC CONTAMINANTS IN POROUS MEDIA OF UNIFORM SPHERICAL PARTICLES,
General Motors Research Labs., Warren, MI. Environmental Science Dept.
For primary bibliographic entry see Field 2G.
W89-06227

FROM CARTOGRAPHIC PROGRAMS TO NETWORK INFORMATION SYSTEMS,
Gelsenwasser A.G., Gelsenkirchen (Germany, F.R.).
H. Nimtz.
Aqua AQUAAA, No. 5, p 261-266, 1988. 6 fig.

Descriptors: *Automation, *Mapping, *Water supply systems, Management planning, Data processing, Computer-aided design, Data base management, Information systems, Computers, Operating policies, Systems analysis, Network design, Pipelines.

The experience of Gelsenwasser AG in developing a network information system (NIS) using standard components and based on the government regulations for automated maps is described. Early cartographic computer systems had significant limitations, but several developments outside the mapping field led to the possibility of developing improved systems at reduced cost. Among these developments were: relational data base management systems, computer-aided design (CAD) systems, application tools, and interactive operating systems. At the same time, West Germany was developing standards for automated mapping systems. Gelsenwasser started in 1987 to develop a network information system based on digitized maps. Software modules needed were: a relational data base management system, a map editor (CAD), a database retrieval language (system query language, SQL), transformation functions, and mapping programs. There are three levels in the system: (1) data acquisition, (2) graphics workstations, and (3) the data base management system. The use of automated data acquisition lowers costs and shortens the time period required for project completions, making building up of a NIS feasible. In the fully configured system, the following data will be stored in the data base section for thematic data: piping network file, building connection file, piping failure statistics, piping network fittings, piping network subsystems (e.g., instrumentation, pressure booster), operational status, and rights and responsibilities. The hardware is configured around local area networks within individual operational centers interconnected by wide area networks. (Rochester-PTT)
W89-06237

APPLICABILITY OF THE SOIL CONSERVATION SERVICE EQUATIONS FOR RUNOFF PREDICTION IN THE OTTAWA-ST. LAWRENCE LOWLANDS,
Macdonald Coll., Ste. Anne de Bellevue (Quebec). Dept. of Agricultural Engineering.
For primary bibliographic entry see Field 2E.
W89-06240

ESTIMATION OF DESCRIPTIVE STATISTICS FOR MULTIPLY CENSORED WATER QUALITY DATA,
Geological Survey, Reston, VA. Water Resources Div.
D. R. Helsel, and T. A. Cohn.
Water Resources Research WRERAO, Vol. 24, No. 12, p 1997-2004, December 1988. 7 tab, 6 fig, 19 ref, 3 append.

Descriptors: *Water quality data, *Detection limits, *Statistical analysis, *Water quality, *Data collections, *Data interpretation, Probability distribution, Estimating, Water quality, Statistical methods, Statistics.

The performance of estimators for data that have multiple detection limits is investigated to determine procedures for estimating descriptive statistics of water quality data that contain 'less than' observations. Probability plotting and maximum likelihood methods perform substantially better than simple substitution procedures now commonly in use. Therefore simple substitution procedures (e.g. substitution of the detection limit) should be avoided. Probability plotting methods are more robust than maximum likelihood methods to misspecification of the parent distribution and their use should be encouraged in the typical situation where the parent distribution is unknown. When utilized correctly, less than values frequently contain nearly as much information for estimating population moments and quantities as would the same observations had the detection limit been below them. (Author's abstract)
W89-06256

FLOW AND TRACER TRANSPORT IN FRACTURED MEDIA: A VARIABLE APERTURE CHANNEL MODEL AND ITS PROPERTIES,
California Univ., Berkeley. Earth Sciences Div.
For primary bibliographic entry see Field 5B.
W89-06260

NONPARAMETRIC STATISTICAL METHODS FOR COMPARING TWO SITES BASED ON DATA WITH MULTIPLE NONDETECT LIMITS,
CH2M/Hill, Bellevue, WA.
S. P. Millard, and S. J. Deverel.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2087-2098, December 1988. 9 tab, 9 fig, 35 ref.

Descriptors: *Water quality data, *Statistical methods, *Data interpretation, *Pollutant identification, *Water quality, Detection limits, Nonparametric tests, Water pollution, Petro-Prentice test, San Joaquin Valley, California.

A need has developed for statistical methods that deal appropriately with data that include values reported as 'less than' the detection limit. It has become increasingly common for water quality data to include censored values that reflect more than one detection limit for a single analyte. In such cases, methods from the biostatistical field of survival analysis are applicable. The tests were applied to shallow groundwater chemistry data from two sites in the San Joaquin Valley, California. The best nonparametric test for comparing median pollution concentrations between two areas based on multiply censored lognormal data is the normal scores test and a permutation variance estimator. This test maintains the nominal alpha level across a wide range of differing sample sizes and censoring mechanisms. Several other competing nonparametric tests for comparing median concentrations are available. These tests and the normal scores tests should yield similar results in cases where sample sizes and censoring mechanisms do not differ greatly between areas. In such cases, the Petro-Prentice test with an asymptotic variance estimator may be a more powerful test. (White-Reimer-PTT)
W89-06263

NOTE ON THE RECENT NATURAL GRADIENT TRACER TEST AT THE BORDEN SITE,
Geological Survey, Denver, CO.
R. L. Naff, T. C. Jim Yeh, and M. W. Kemblowski.
Water Resources Research WRERAO, Vol. 24, No. 12, p 2099-2103, December 1988. 4 fig, 15 ref.

Descriptors: *Groundwater movement, *Statistical analysis, *Tracers, *Obstruction to flow, *Model studies, Hydrologic models, Two-dimensional flow, Three-dimensional flow, Borden site studies.

The variance in particle position, a measure of dispersion, in the context of certain models of flow in random porous media is discussed. The original model for the Borden site (Ontario, Canada) studies allowed for only a two-dimensional flow. However, the model which allows for a three dimensional flow does not supply a superior fit to the concentration moments, especially when the original field statistics for media and velocity properties are considered. It has been demonstrated that a relatively small change (25%) in one parameter (lambda) will cause the three dimensional flow model to have an adequate fit. In addition, there are early time inconsistencies in modeling a field pulse input, which could cause discrepancies in fitting a theoretical model to field moments. Finally, the evidence indicates a three-dimensional flow field. Therefore, the three-dimensional flow model should have been the superior model and its lack of fit to the field moments is puzzling. These findings point up the need for enhanced methods of determining the statistical properties of the medium. (White-Reimer-PTT)
W89-06264

VARIABILITY OF EMPIRICAL FLOW QUANTILES,
California Univ., Santa Barbara. Dept. of Geography.
H. A. Loaiciga.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 82-100, January 1989. 4 tab, 2 fig, 22 ref, append. U.S. Corps of Engineers contract DACW05-86-P-3113.

Descriptors: *Streamflow forecasting, *Flow measurement, *Statistical analysis, *Statistics, *Statistical methods, Variability, Empirical flow quantiles, American River, Folsom Reservoir, California.

Empirical quantiles constitute a simple alternative for estimating flow values for which there is a specified nonexceedance probability. The standard error of empirical quantile estimators is a measure of the variability to be expected about the numerical estimates obtained from flow records. It is shown in this work that the standard error of empirical flow quantiles is a function of: (1) The specified probability level associated with a particular quantile; (2) the sample size used in the estimation; and (3) the probability density function governing the realization of flow variates. An example using a series of annual runoff from 1904-1986 in the American River at Folsom Reservoir, California, shows that empirical flow quantiles are efficient, i.e., have standard errors of estimates not exceeding 10% of the actual quantile value when the return periods involved are less than 100 years and the flow record is moderately large. Results from Monte Carlo simulations indicate that the approximate expression for standard error of the empirical quantile derived in the work is accurate to within + or - 10% of population values. (Author's abstract)
W89-06279

MODEL FOR CALCULATING BED LOAD TRANSPORT OF SEDIMENT,
Washington Univ., Seattle. Dept. of Geological Sciences.
For primary bibliographic entry see Field 2J.
W89-06280

ESTIMATION OF PRODUCTION FORGONE,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6G.
W89-06290

WATER QUALITY CONTROL TRIALS: STATISTICAL TABLES FOR DIRECT COMPARISON BETWEEN MEMBRANE FILTRATION BACTERIAL COUNTS AND THE MULTIPLE TUBE METHOD WITH A DESCRIPTION OF THE BACTERIOLOGICAL METHOD,
Central Public Health Lab., London (England). Communicable Disease Surveillance Centre.
For primary bibliographic entry see Field 5A.
W89-06312

INPUT OF RIVER-DERIVED SEDIMENT TO THE NEW ZEALAND CONTINENTAL SHELF: II. MINERALOGY AND COMPOSITION,
New Zealand Soil Bureau, Lower Hutt.
For primary bibliographic entry see Field 2J.
W89-06314

DISTRIBUTION OF UPPER AND MIDDLE OHIO RIVER FISHES, 1973-1985: II. INFLUENCE OF ZOOGEOGRAPHIC AND PHYSIOCHEMICAL TOLERANCE FACTORS,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
For primary bibliographic entry see Field 8I.
W89-06319

PREDICTABILITY OF CHANGE IN SHORELINE VEGETATION IN A HYDROELECTRIC RESERVOIR, NORTHERN SWEDEN,
Umea Univ. (Sweden). Dept. of Ecological Botany.
For primary bibliographic entry see Field 2I.

W89-06375

PATTERNS IN BIOMASS AND COVER OF AQUATIC MACROPHYTES IN LAKES: A TEST WITH FLORIDA LAKES,
Florida Univ., Gainesville. Dept. of Fisheries and Aquaculture.
For primary bibliographic entry see Field 2H.
W89-06379

IMPROVED FOUR-POINT SOLUTION OF THE KINEMATIC EQUATIONS,
University of the Witwatersrand, Johannesburg (South Africa). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-06399

PREDICTION OF FLOW CHARACTERISTICS IN MAIN CHANNEL/FLOOD PLAIN FLOWS,
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
R. J. Keller, and W. Rodi.
Journal of Hydraulic Research JHYRAF, Vol. 26, No. 4, p 425-441, 1988. 7 fig, 2 tab, 26 ref.

Descriptors: *Mathematical models, *Channel flow, *Flood plains, *Flow characteristics, Compound cross-section, Open-channel flow, hydraulic properties, Flumes.

A two-dimensional mathematical model to calculate flow characteristics in channels of compound cross-section uses a previously developed depth-averaged form of the kappa-epsilon turbulence model. The model was tested against velocity and bed shear stress data taken from the literature and obtained in laboratory flumes modeling a main channel/flood plain geometry. Comparisons between these data and model predictions show generally good agreement. One necessary input to the model is the dimensionless transverse eddy diffusivity, which has a significant influence on the predicted distributions. A value of 0.15, adopted from the literature for rectangular laboratory flumes, is show to be appropriate for laboratory compound channels. However, application of the model to natural compound channels requires further investigation of this parameter. (Author's abstract)
W89-06400

LAND USE CONSIDERATIONS IN REDUCING OIL AND GREASE IN URBAN STORMWATER RUNOFF,
Bowling Green State Univ., OH.
For primary bibliographic entry see Field 5G.
W89-06401

MODEL FOR IRREVERSIBLE ADSORPTION HYSTERESIS,
Stevens Inst. of Tech., Hoboken, NJ. Dept. of Civil and Ocean Engineering.
For primary bibliographic entry see Field 5B.
W89-06411

AGGREGATED MIXING ZONE MODEL OF SOLUTE TRANSPORT THROUGH POROUS MEDIA,
Lancaster Univ. (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5B.
W89-06422

MODELING TRACER DIFFUSION IN FRACTURED AND UNFRACTURED, UNSATURATED, POROUS MEDIA,
Los Alamos National Lab., NM.
For primary bibliographic entry see Field 5B.
W89-06423

KINEMATIC WAVE APPROXIMATION TO SOLUTE TRANSPORT ALONG PREFERRED FLOW PATHS IN SOILS,
Camp, Dresser and McKee, Inc., Boston, MA.
For primary bibliographic entry see Field 5B.
W89-06429

APPLICATION OF SIMPLE SOIL-WATER FLOW MODELS TO THE TRANSFER OF SURFACE-APPLIED SOLUTES TO STREAMS,
Sheffield Univ. (England). Dept. of Geology.
For primary bibliographic entry see Field 5B.
W89-06435

TEMPORAL SENSITIVITY OF APHANIZOMENON FLOS-AQUAE DOMINANCE: A WHOLE-LAKE SIMULATION STUDY WITH INPUT PERTURBATIONS,
Helsinki Univ. of Technology, Espoo (Finland). Lab. of Hydrology and Water Resources Engineering.
For primary bibliographic entry see Field 2H.
W89-06451

MINLAKE: A DYNAMIC LAKE WATER QUALITY SIMULATION MODEL,
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 2G.
W89-06452

COMPLEX MARKOV MODELS TO SIMULATE PERSISTENT STREAMFLOWS,
Technical Univ. of Istanbul (Turkey). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2E.
W89-06454

ANALYSIS OF PUMP TEST DATA FOR A LARGE-DIAMETER WELL NEAR A HYDROGEOLOGICAL BOUNDARY,
National Geophysical Research Inst., Hyderabad (India).
For primary bibliographic entry see Field 2F.
W89-06456

VALIDITY OF FIRST-ORDER PREDICTION LIMITS FOR CONCEPTUAL HYDROLOGIC MODELS,
Newcastle Univ. (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 2A.
W89-06457

FINITE ELEMENT MODEL OF NITROGEN SPECIES TRANSFORMATION AND TRANSPORT IN THE UNSATURATED ZONE,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 5B.
W89-06458

EFFECT OF BASEFLOW SEPARATION PROCEDURES ON SURFACE RUNOFF MODELS,
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Water Resources.
For primary bibliographic entry see Field 2E.
W89-06461

PRACTICAL GENERATION OF SYNTHETIC RAINFALL EVENT TIME SERIES IN A SEMI-ARID CLIMATIC ZONE,
Asian Inst. of Tech., Bangkok (Thailand). Div. of Water Resources Engineering.
For primary bibliographic entry see Field 2B.
W89-06465

CLIMATE-BASED REPRESENTATIONS OF SUMMER RAINFALL IN ILLINOIS,
Illinois State Water Survey Div., Champaign. Climatology and Meteorology Section.
For primary bibliographic entry see Field 3B.
W89-06467

ENVIRONMENTAL BEHAVIOR OF CHEMICALS IN SOIL: ATRAZINE AS AN EXAMPLE,
Istituto Superiore di Sanita, Rome (Italy).
For primary bibliographic entry see Field 5B.
W89-06473

APPROACHES TO MODELING TOXIC RESPONSES OF AQUATIC ORGANISMS TO AROMATIC HYDROCARBONS,
Istituto di Ricerca sulle Acque, Brugherio (Italy).
For primary bibliographic entry see Field 5C.
W89-06475

SAMPLING ERROR STUDY FOR RAINFALL ESTIMATE BY SATELLITE USING A STOCHASTIC MODEL,
Texas A and M Univ., College Station. Coll. of Geosciences.
For primary bibliographic entry see Field 7B.
W89-06479

CLIMATOLOGICAL VARIABILITY OF SULFUR DEPOSITIONS IN EUROPE,
Environmental Protection Agency, Washington, DC. Office of Air and Radiation.
For primary bibliographic entry see Field 2B.
W89-06486

ASSESSMENT OF IMPACTS OF POSSIBLE CLIMATE CHANGES ON THE RESULTS OF THE IIASA RAINS SULFUR DEPOSITION MODEL IN EUROPE,
International Inst. for Applied Systems Analysis, Laxenburg (Austria).
For primary bibliographic entry see Field 5B.
W89-06487

LINEAR PROGRAMMING FOR ABATEMENT OF NITROGEN OXIDES ACID RAIN DEPOSITION,
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 5B.
W89-06489

TWO-DIMENSIONAL FINITE ELEMENT MODEL FOR DISPERSION (2D-FED) IN COASTAL AQUIFERS,
Louisiana State Univ., Baton Rouge. Dept. of Civil Engineering.
For primary bibliographic entry see Field 2F.
W89-06509

CALIBRATION, SENSITIVITY AND VALIDATION OF A PHYSICALLY-BASED RAINFALL-RUNOFF MODEL,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2A.
W89-06514

THEORY OF RUNS WITH APPLICATIONS TO DROUGHT PREDICTION,
Texas Univ., Houston. School of Public Health.
For primary bibliographic entry see Field 2E.
W89-06516

USE OF POLYNOMIAL EXPRESSIONS TO DESCRIBE THE BIOCONCENTRATION OF HYDROPHOBIC CHEMICALS BY FISH,
Griffith Univ., Nathan (Australia). School of Australian Environmental Studies.
For primary bibliographic entry see Field 5B.
W89-06524

INTERANNUAL VARIABILITY OF WINTER MEAN PRECIPITATION AND UPPER-LEVEL CIRCULATION IN EXTENDED GCM INTEGRATIONS WITH AND WITHOUT INTERANNUAL VARIATION OF TROPICAL PACIFIC SST,
Seoul National Univ. (Republic of Korea). Dept. of Atmospheric Sciences.
For primary bibliographic entry see Field 2B.
W89-06537

IMPROVED METHODOLOGY FOR SHORT-TERM OPERATION OF A SINGLE MULTI-PURPOSE RESERVOIR,

Manitoba Univ., Winnipeg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W89-06574

UNSATURATED VERTICAL FLOWS ABOVE A WATER TABLE,
Department of Scientific and Industrial Research, Wellington (New Zealand). Applied Mathematics Div.
For primary bibliographic entry see Field 2G.
W89-06580

SOLUTIONS APPROXIMATING SOLUTE TRANSPORT IN A LEAKY AQUIFER RECEIVING WASTEWATER INJECTION,
New Mexico Inst. of Mining and Technology, Socorro. Dept. of Geoscience.
For primary bibliographic entry see Field 5B.
W89-06581

MODELING THE TRANSPORT OF VOLATILE ORGANICS IN VARIABLY SATURATED MEDIA,
Waterloo Univ. (Ontario). Dept. of Mechanical Engineering.
For primary bibliographic entry see Field 5B.
W89-06583

CRITICAL EVALUATION OF RECENT DEVELOPMENTS IN HYDROGEOCHEMICAL TRANSPORT MODELS OF REACTIVE MULTICHEMICAL COMPONENTS,
Oak Ridge National Lab., TN. Environmental Sciences Div.
G. T. Yeh, and V. S. Tripathi.
Water Resources Research WRERAO, Vol. 25, No. 1, p 93-108, January 1989. 6 tab, 46 ref, append.

Descriptors: *Path of pollutants, *Solute transport, *Groundwater pollution, *Mathematical models, *Multivariate analysis, *Model testing, Geohydrology, Chemical reactions.

Many hydrogeochemical models have appeared in recent years for simulating subsurface solute transport. The hydrological transport of solutes can be described by a set of linear partial differential equations, and the chemical equilibria are described by a set of nonlinear algebraic equations. Three approaches are currently used to formulate the problem: (1) the mixed differential and algebraic equation (DAE) approach, (2) the direct substitution approach (DSA), and (3) the sequential iteration approach (SIA). An extremely important consideration in any approach is the choice of primary dependent variables (PDVs). Six types of PDVs have been employed in the existing models. Because of many possible combinations of PDVs and approaches, many hydrogeochemical transport models for multicomponent systems have been developed. This paper critically evaluates and discusses these models in terms of: (1) how severe can the constraints be that a model imposes on computer resources, (2) which equilibrium geochemical processes can a model include, and (3) how easily can a model be modified to deal with mixed kinetic and equilibrium reactions. The use of SIA models leads to the fewest constraints on computer resources in terms of central processing unit (CPU) memory and CPU time; both DAE and DSA models require excessive CPU memory and CPU time for realistic two- and three-dimensional problems. DAE and SIA models require strenuous efforts to modify for treating mixed chemical kinetics and equilibria. Therefore SIA models using the type of PDV that uses total analytical concentrations of aqueous components are recommended for their practicality and flexibility. DSA and DAE models should remain research tools for one-dimensional investigations. (Author's abstract)
W89-06584

MULTIDIMENSIONAL STEADY INFILTRATION TO A WATER TABLE,
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Environmental Mechanics.
For primary bibliographic entry see Field 2G.
W89-06585

REGIONAL SCALE TRANSPORT IN A KARST AQUIFER: 2. LINEAR SYSTEMS AND TIME MOMENT ANALYSIS,
California Univ., Santa Cruz. Dept. of Earth Sciences.
For primary bibliographic entry see Field 2F.
W89-06587

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME III.
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 2L.
W89-06621

ECOSYSTEM ANALYSIS OF THE CALCASIEU RIVER/LAKE COMPLEX (CALECO). VOLUME IV.
McNeese State Univ., Lake Charles, LA.
For primary bibliographic entry see Field 2L.
W89-06622

MULTIPLY-CONNECTED CHANNEL MODE OF TIDES AND TIDAL CURRENTS IN PUGET SOUND, WASHINGTON AND A COMPARISON WITH UPDATED OBSERVATIONS,
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 2L.
W89-06632

STATISTICAL ANALYSIS OF GEOTECHNICAL DATA,
Nexus Associates, Wayland, MA.
G. Baecher.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A186 797. Price codes: A06 in paper copy, A01 in microfiche. Contract Report GL-87-1, September 1987. Final Report. 150p, 52 fig, 4 tab, 5 plates, 20 ref, 2 append. Department of the Army Contract DACW39-83-M-0067.

Descriptors: *Geophysics, *Statistical analysis, *Data interpretation, *Geotechnical data, *Soil engineering, *Soil properties, Statistical methods, Geotechnology, Error analysis, Soil profiles, Soil tests, Estimating.

The purpose of this report is to provide potential users of statistical methods for geotechnical data analysis with an introduction to practical concepts, definitions, and techniques. The approach summarizes soil parameters by two numbers: a best estimate and a measure of uncertainty. Uncertainties in soil parameter estimates of four types are considered--(a) variability in the soil deposit; (b) random measurement error; (c) measurement bias; (d) limited numbers of tests. The first two cause data scatter, and the second two cause systematic error. A procedure is developed to assess each source individually and then to combine them into a statistical soil profile. The statistical profile shows the best estimate of soil properties with depth and uncertainty envelopes about that profile. The statistical design profile is the first step in error analysis. (See also W89-06652) (Lantz-PTT)
W89-06651

ERROR ANALYSIS FOR GEOTECHNICAL ENGINEERING,
Nexus Associates, Wayland, MA.
G. Baecher.
Available from National Technical Information Service, Springfield, VA 22161, as AD-A186 795. Price codes: A07 in paper copy, A01 in microfiche. Contract Report GL-87-3, September 1987. Final Report. 128p, 38 fig, 5 tab, 8 plates, 17 ref, append. Department of the Army Contract DACW39-83-M-0067.

Descriptors: *Geotechnical data, *Geophysics, *Error analysis, *Geotechnology, *Soil engineering, Statistical analysis, Mathematical studies, Prediction.

An introduction to practical techniques of error analysis for geotechnical engineering, is provided in this report. The intended audience is the practicing geotechnical engineer with little background in probability or statistics. An analysis procedure is presented by which errors entering geotechnical calculations can be quantified and their effect on predictive accuracy evaluated. The approach involves three phases: (1) identification of potential sources of error; (2) assessment of the magnitude of each source; and (3) determination of the influence of each source on calculations. (See also W89-06651) (Author's abstract)
W89-06652

PHYSICS OF IMMISCIBLE FLOW IN POROUS MEDIA,
Virginia Polytechnic Inst. and State Univ., Blacksburg.
For primary bibliographic entry see Field 5B.
W89-06658

GUIDELINES FOR DETERMINING FLOOD FLOW FREQUENCY.
Geological Survey, Washington, DC. Office of Water Data Coordination.
Bulletin 17B of the Hydrology Subcommittee, March 1982. 186p, 1 tab, 43 ref, 14 append.

Descriptors: *Flood recurrence interval, *Flood flow, *Standards, *Flood frequency, *Statistical analysis, Stream gages, Reservoir releases, Dam failure, Hydrologic data collections, Computer programs, Risk.

This guide describes the data and procedures for computing flood flow frequency curves where systematic stream gaging records of sufficient length (at least 10 years) to warrant statistical analysis are available as the basis for determination. The procedures do not cover watersheds where flood flows are appreciably altered by reservoir regulation or where the possibility of unusual events, such as dam failures, must be considered. The guide was specifically developed for the treatment of flood peak discharge. It is recognized that the same techniques could also be used to treat other hydrologic elements, such as flood volumes. Such applications, however, were not evaluated and are not intended. Flood data categories recognized in this publication are systematic records, historic data, comparison with similar watersheds, and flood estimates from precipitation. Basic data assumptions are presented as a reminder to those developing flood-flow frequency curves to be aware of potential data errors. Besides determination of the frequency curve, procedures for computing confidence limits to the frequency curve are provided along with those for calculating risk and for making expected probability adjustments. Included in the appendix are a glossary and list of symbols, tables of K values, the computational details for treating most of the recommended procedures and information about how to obtain a computer program for handling the statistical analysis and treatment of data. (Lantz-PTT)
W89-06662

SNOW COVER AS AN INDICATOR OF CLIMATE CHANGE,
Lamont-Doherty Geological Observatory, Palisades, NY.
For primary bibliographic entry see Field 2C.
W89-06672

EXPERT SYSTEMS IN WEATHER FORECASTING AND OTHER METEOROLOGICAL APPLICATIONS,
Air Force Geophysics Lab., Hanscom AFB, MA.
R. M. Dyer.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A186 837. Price codes: A02 in paper copy, A01 in microfiche. October 1987. 6p, 6 ref.

Descriptors: *Expert systems, *Artificial intelligence, *Weather forecasting, *Data interpretation, *Meteorology, *Computer models, Fog, Computer programs, Artificial intelligence, Computers, Prediction, Quality control, Data acquisition, Human interface.

Weather forecasting is an activity that seems to meet all the criteria necessary for a successful application of artificial intelligence (AI) techniques, particularly expert systems. The past two years have seen the development of several expert systems designed to assist the operational forecaster who must produce accurate weather predictions in a timely fashion. Although these have all demonstrated an ability to produce correct results, much remains to be done to improve user interfaces and data input before such systems can be used operationally. The experience of the meteorological community in developing expert systems may be of some value to workers in related fields. The systems already developed fall into two categories. The first is typified by the expert systems for the prediction of a single phenomenon at a single location. The second, of which the system designed for Kennedy Space Center is representative, uses object programming to interpret data from several sources. Other uses of AI include data quality control and data analyses that involve interpretation as well as computation. These uses are common to other physical sciences and are not limited to meteorology. The future of AI in meteorology depends heavily on progress in solving the fundamental problems of machine learning and image processing. (Author's abstract)
W89-06674

NUMERICAL MODEL FOR THREE-DIMENSIONAL HYDRODYNAMIC TRANSPORT: DOCUMENTATION OF THE COMPUTER PROGRAM,
Environmental Research Lab., Narragansett, RI.
For primary bibliographic entry see Field 5B.
W89-06675

REVERSIBILITY OF ACIDIFICATION.
For primary bibliographic entry see Field 5G.
W89-06680

MODELLING REVERSIBILITY OF ACIDIFICATION WITH MATHEMATICAL MODELS,
Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5G.
W89-06692

METEOROLOGICAL USE OF EVAPORATION DATA,
Royal Netherlands Meteorological Inst., De Bilt.
For primary bibliographic entry see Field 2D.
W89-06699

FROM PENMAN TO MAKKINK,
Agricultural Univ., Wageningen (Netherlands). Dept. of Physics and Meteorology.
For primary bibliographic entry see Field 2D.
W89-06700

CLIMATOLOGICAL DATA ON EVAPORATION IN THE NETHERLANDS: PAST, PRESENT AND FUTURE,
Royal Netherlands Meteorological Inst., De Bilt.
For primary bibliographic entry see Field 2D.
W89-06702

INTERNATIONAL INVESTIGATIONS OF LARGE-SCALE EVAPORATION,
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 2D.
W89-06704

COMPUTERIZED DATA MANAGEMENT SYSTEM FOR U.S. EPA QA/QC METHODS,
Acres International Ltd., Niagara Falls (Ontario). Environmental Dept.
A. W. Panko, and T. O. DiFruscio.
IN: Chemical and Biological Characterization of Municipal Sludges, Sediments, Dredge Spoils, and Drilling Muds. American Society for Testing and Materials, Philadelphia, PA. 1988. p 35-43, 4 fig, 4 ref.

Descriptors: *Computer programs, *Quality control, *Quality assurance, *Water analysis, *Standards, Sludge, Sediments, Errors, Laboratory procedures, Data processing, Data storage and retrieval.

A user-friendly IBM-PC-compatible computer program is capable of managing the quality assurance/quality control (QA/QC) requirements of any size laboratory performing analysis to EPA specifications. The program design criteria address the QA/QC requirements for the analysis of sludges, sediments, waters, and other materials. The database is initialized using well-established standard data for solids and liquids (e.g., Standard Reference Materials form the National Bureau of Standards). The analyst enters the following QC data for the parameters of interest into the database: found concentrations for internal and/or external standards, values for blanks, spike recoveries, replicates, duplicates, and midpoint internal standards. This step is performed for each parameter for each discrete sample set or analytical run. The program then generates control charts for these parameters and creates a QC data sheet, which documents all aspects of the QA/QC requirements for chemical analysis as specified by the EPA. The database management system also transfers the QA/QC documentation into a universal format that can be used in statistical and spreadsheet software, such as Lotus 1-2-3, Supercalc 4, Chartmaster, and others. This allows a wide range of statistical and graphical manipulations to be performed on both the QA/QC data and the analytical data. (See also W89-06705) (Author's abstract)
W89-06711

PREDICTING TRANSPORT BEHAVIOR OF ORGANIC POLLUTANTS USING SIMPLE MATHEMATICAL MODELS,
Rijksinstituut voor Zuivering van Afvalwater, Lelystad (Netherlands).
P. S. Griffioen, and D. van de Meent.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 144-153. 4 fig, 3 ref.

Descriptors: *Model studies, *Path of pollutants, *Organic compounds, *Stream pollution, Prediction, Flow velocity, Stream hydrology, Sedimentation, Streamflow, Cross-sections, Roughness coefficient.

Two simple models are presented for the prediction of transport behavior of pollutants, in case of accidents in a river. The first model is especially suitable for predicting transport in the neighborhood of the accident, while the second model can be used for longer distances, including inflow, outflow and velocity variations. Relevant model parameters are discussed and attention is paid to the description of elimination processes. The effects of exchange processes, not accounted for by the models, are discussed. The first model describes the lateral phase of the mixing and transport of pollutants in rivers. For distances greater than the mixing length, three equations are presented for predicting the cross-sectional averaged concentration downriver from an accident; all three equations are based on stationary (i.e. time independent) hydrologic conditions, but differ with respect to assumptions about constant velocity and cross-section along the river, constant velocity and varying cross-section, and varying velocity and cross-section. A semi-empirical expression is presented that relates the dispersion coefficient to bottom roughness and flow velocity. This equation can be used for extrapolation and interpolation under various conditions. Elimination processes are also accounted for in the models, with terms for sedimentation, resuspension, water-air volatilization, and adsorption/dissolution. Bottom stagnation is also represented in the models. (See also W89-06748) (Friedmann-PTT)
W89-06769

EVALUATION OF SOME CHEMICAL FATE AND TRANSPORT MODELS. A CASE STUDY ON THE POLLUTION OF THE NORRSUNDET BAY (SWEDEN),
Senter for Industriforskning, Oslo (Norway).
For primary bibliographic entry see Field 5B.
W89-06796

MODELING OF GROUNDWATER TRANSPORT OF MICROORGANIC POLLUTANTS: STATE-OF-THE-ART,
Vrije Univ., Brussels (Belgium). Lab. of Hydrology.
For primary bibliographic entry see Field 5B.
W89-06797

MODELING OF SURFACTANTS IN THE COMUNIDAD DE MADRID AS SUBBASIN OF TAGUS RIVER,
Comunidad de Madrid (Spain). Models and Technology Div.
For primary bibliographic entry see Field 5B.
W89-06798

MODELING OF ANTHROPOGENIC SUBSTANCES IN AQUATIC SYSTEMS: MASAS - A PERSONAL COMPUTER APPROACH,
Eidgenoessische Anstalt fuer Wasserversorgung, Abwasserreinigung und Gewaesserschultz, Duebendorf (Switzerland).
R. P. Schwarzenbach, J. Wetzel, J. Heldstab, and D. M. Imboden.
IN: Organic Micropollutants in the Aquatic Environment: Proceedings of the Fifth European Symposium, Held in Rome, Italy, October 20-22, 1987. Kluwer Academic Publishers, Boston, MA. 1988. p 408-414. 2 fig, 3 tab, 4 ref, append.

Descriptors: *Model studies, *Mathematical models, *Path of pollutants, *Water pollution, *Data storage and retrieval, Data processing, Dynamic programming, Physicochemical properties, Lakes, Rivers, Aquifers, Groundwater pollution, Stream pollution, Aquatic environment, Computers.

Mathematical models for evaluating the dynamic behavior of anthropogenic substances in aquatic systems (MASAS) are being developed and implemented on a personal computer. The goals of the MASAS project are outlined, and the model is described. To provide maximum flexibility, the whole system is divided into three major program modules, namely 'Compounds,' 'Systems,' and 'Models.' Each of these modules plays a different role in the modeling process, and the modules 'Compounds' and 'Systems' may also be used as independent units. The module 'Compounds' serves as a standalone database containing specific properties and parameters of the compounds; 'Systems' describes physical systems, such as lakes, rivers, or aquifers; 'Models' combines the data derived from the two other modules and provides the mathematical framework for the desired model calculations. The MASAS system will allow the user to construct models of increasing complexity, and to build up compound and system libraries. (See also W89-06748) (Friedmann-PTT)
W89-06799

TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES FROM URBAN BASINS IN MISSOURI,
Geological Survey, Rolla, MO. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06831

GEOHYDROLOGY AND SIMULATED RESPONSE TO GROUND-WATER PUMPAGE IN CARSON VALLEY, A RIVER-DOMINATED BASIN IN DOUGLAS COUNTY, NEVADA, AND ALPINE COUNTY, CALIFORNIA,
Geological Survey, Carson City, NV. Water Re-

sources Div.
For primary bibliographic entry see Field 2F.
W89-06834

MAGNITUDE AND FREQUENCY OF FLOODS IN ARKANSAS,
Geological Survey, Little Rock, AR. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06835

VERIFICATION OF REGRESSION EQUATIONS FOR ESTIMATING FLOOD MAGNITUDES FOR SELECTED FREQUENCIES ON SMALL NATURAL STREAMS IN GEORGIA,
Geological Survey, Doraville, GA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06837

SIMULATION OF THE GROUND-WATER FLOW SYSTEM AND PROPOSED WITHDRAWALS IN THE NORTHERN PART OF VEKOL VALLEY, ARIZONA,
Geological Survey, Tucson, AZ. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06839

LOW-FLOW-FREQUENCY CHARACTERISTICS FOR CONTINUOUS-RECORD STREAMFLOW STATIONS IN MINNESOTA,
Geological Survey, St. Paul, MN. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06842

POTENTIOMETRIC SURFACE OF THE UPPER FLORIDAN AQUIFER IN FLORIDA AND IN PARTS OF GEORGIA, SOUTH CAROLINA, AND ALABAMA, MAY 1985,
Geological Survey, Atlanta, GA. Water Resources Div.
P. W. Bush, G. L. Barr, J. S. Clarke, and R. H. Johnston.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4316, 1987. 1p, 8 ref.

Descriptors: *Potentiometric level, *Floridan aquifer, *Aquifers, *Maps, *Florida, Georgia, South Carolina, Alabama, Groundwater level, Groundwater recharge, Rainfall, Groundwater irrigation, Artesian pressure.

A map, constructed as a part of the Floridan Regional Aquifer-System Analysis (RASA), shows the potentiometric surface of the Upper Floridan aquifer for May 1985. It is based on measurements of water level or artesian pressure made in about 2,500 wells during the period May 13 to 24, 1985. Only measurements from tightly cased wells open exclusively to the Upper Floridan aquifer were used to make the map. These included 1,425 wells in Florida, 924 in Georgia, 133 in South Carolina, and 21 in Alabama. The potentiometric surface of the Upper Floridan aquifer changed little between 1980 and 1985. Significant water level declines were observed only in southwest Georgia and west-central Florida. Low rainfall during early 1985 and associated pumping for irrigation caused the declines in both areas. (Lantz-PTT)
W89-06850

LOUISIANA GROUND-WATER MAP NO. 1: POTENTIOMETRIC SURFACE, 1985, AND WATER-LEVEL CHANGES, 1983-85, OF THE CHICOT AQUIFER IN SOUTHWESTERN LOUISIANA,
Geological Survey, Baton Rouge, LA. Water Resources Div.
R. B. Fendick, and D. J. Nyman.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4348, 1987. 1p, 5 fig, 3 tab, 10 ref.

Descriptors: *Groundwater, *Maps, *Potentiometric level, *Chicot Aquifer, *Louisiana, Groundwater level, Groundwater mining, Hydrologic studies.

The Chicot aquifer is the principle source of groundwater in southwestern Louisiana and is the most extensively pumped (nearly 1 billion gallons per day) aquifer in the State. Withdrawals from the Chicot aquifer are used primarily for irrigation. Two maps show the generalized potentiometric surfaces of the upper sand unit ('200-ft' sand in the Lake Charles area) and the '500-ft' sand of the Chicot aquifer. General water level altitudes and flow directions may be inferred from these maps which were prepared in cooperation with the Louisiana Department of Transportation and Development, Office of Public Works. Previous studies of groundwater hydrology in southwestern Louisiana are included in selected references. (Lantz-PTT)
W89-06851

PERCENTAGE CHANGE IN SATURATED THICKNESS OF THE HIGH PLAINS AQUIFER, WEST-CENTRAL KANSAS, 1950 TO AVERAGE 1984-86,
Geological Survey, Lawrence, KS. Water Resources Div.
B. J. Dague.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 86-4365, 1986. 1p, 14 ref.

Descriptors: *Water table decline, *Groundwater level, *High Plains Aquifer, *Aquifers, *Saturated thickness, *Kansas, *Maps, *Groundwater depletion, Kriging, Statistical methods, Groundwater budget, Groundwater irrigation.

Continuing studies are being made in west-central Kansas to provide up-to-date information that will aid in the management of groundwater for irrigation. The results are presented of the sixth in a series of studies that used a statistical technique called kriging, to produce hydrologic maps. The kriging technique interpolates water level altitudes at the center of each 1 sq mi section in the study area on the basis of water level measurements from 169 observation wells. For this study, measurements made at each site during the winter months of 1984, 1985, and 1986 were averaged. These interpolated altitudes (1,859 in all), along with bedrock-surface and base yr water level altitudes, were used to prepare a hydrologic map that illustrates percentage change in saturated thickness. Saturated thickness is the thickness of the High Plains aquifer between the groundwater surface, as indicated by water level altitudes, and the bedrock surface. Because irrigation development in west-central Kansas was minimal prior to 1950, the saturated thickness during 1950 represented a nearly static condition in the aquifer. Thus, the decrease in saturated thickness of the aquifer since 1950 is related to the effects of irrigation withdrawals on the volume of water in storage. (Lantz-PTT)
W89-06852

FINITE-ELEMENT SIMULATION OF GROUND-WATER FLOW IN THE VICINITY OF YUCCA MOUNTAIN, NEVADA-CALIFORNIA,
Geological Survey, Denver, CO. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06868

THREE-DIMENSIONAL MODEL SIMULATION OF STEADY-STATE GROUND-WATER FLOW IN THE ALBUQUERQUE-BELEN BASIN, NEW MEXICO,
Geological Survey, Albuquerque, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06869

POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER AND ITS USE IN MANAGEMENT OF WATER RESOURCES, ST. JOHNS RIVER WATER MANAGEMENT DISTRICT, FLORIDA,
Geological Survey, Tallahassee, FL. Water Resources Div.
H. G. Rodis, and D. A. Munch.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 83-4176, 1983. 1p, 7 fig, 12 ref.

Descriptors: *Aquifers, *Surface-groundwater relations, *Potentiometric level, *Floridan aquifer, *Groundwater management, *Saint Johns River, *Florida, Groundwater recharge, Rainfall, Groundwater budget, Aquifers.

The Floridan aquifer supplies most of the fresh groundwater for municipal, industrial, and agricultural uses within the 12,400 sq mi St. Johns River Water Management District. Because of the growing demand for water and the variation in rainfall, resource managers need timely information on short-term and long-term changes in the availability of fresh water. The purpose of this report is to explain potentiometric surface maps and their value in assessing the resource, particularly during drought conditions. The Floridan aquifer is recharged by rainfall falling directly on the outcrop of the aquifer, and, where the aquifer is overlain by the surficial aquifer with the water table above the potentiometric surface of the Floridan, by water infiltrating downward from the overlying surficial aquifer. Water is discharged by pumping and free-flowing wells, springflow, and upward leakage into overlying formations, streams, and lakes or into the ocean. Fluctuations in the potentiometric surface reflect net gains (recharge) or losses (discharge) of water stored in the aquifer. Net gains occur during the wet season (June through September) when recharge exceeds discharge and causes the potentiometric surface to rise in most places. Net losses in storage, and declines in the potentiometric surface, follow during the dry season (October through May) when discharge exceeds recharge. Seasonal changes in the potentiometric surface, based on a 2-yr average of water level measurements during May and September 1977, and May and September 1978, are illustrated. Two of the greater long-term declines in the potentiometric surface have occurred in the growing metropolitan areas of Jacksonville and Orlando-Winter Park, the two largest public suppliers of water in the Water Management District. Municipal pumpage increased in Jacksonville from 37 million gallons per day (mgd) in 1961 to 56 mgd in 1980. The increased pumpage and a deficiency in rainfall of 15.8 inches contributed to a decline in the potentiometric surface of as much as 15 ft. Orlando-Winter Park municipal pumpage increasing from 27 mgd in 1961 to 62 mgd in 1980. The periodic preparation of maps showing changes in the potentiometric surface of the aquifer provide the best base information for both short-term and long-term management of the water resources in the St. Johns River Water Management District. (Lantz-PTT)
W89-06873

MAPS SHOWING GROUND-WATER UNITS, GROUND-WATER LEVELS, SPRINGS, AND DEPTH TO GROUND WATER, BASIN AND RANGE PROVINCE, IDAHO,
Geological Survey, Boise, ID. Water Resources Div.
J. E. Reed, M. S. Bedinger, W. H. Langer, D. A. Mulvihill, and J. L. Mason.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 83-4117-A, 1984. 1p, 4 fig, 10 ref.

Descriptors: *Radioactive waste disposal, *Groundwater movement, *Groundwater level, *Maps, *Idaho, *Springs, Groundwater budget, Groundwater, Water table, Aquifers.

This report was prepared as part of a program to identify prospective regions for further study relative to the isolation of high-level nuclear waste. Also included are selected references on pertinent

geologic and hydrologic studies of the region. The map on groundwater units shows boundaries of groundwater units, generalized directions of groundwater flow at the water table, areas of natural discharge to streams and lakes, areas of natural discharge by evapotranspiration in areas underlain by groundwater at shallow depths, and the distribution of consolidated rock outcrops and areas underlain by basin fill. Groundwater units shown on the map may contain one or more areas of natural recharge and natural discharge. Some groundwater units comprise closed flow systems at the water table; that is, no groundwater flow occurs across the groundwater unit boundaries. However, groundwater flow may occur across some unit boundaries in basin-fill or consolidated rock aquifers. The groundwater levels and springs map shows the altitude of the groundwater level and the discharge and temperature of selected springs. The groundwater level map is a compilation of water level measurements taken over a number of years. However, for any one groundwater study area the measurements generally were made during a relatively short time period. Collectively, the groundwater levels show the regional configuration of the groundwater surface. Similarly, the reported values for individual springs were taken at one time; however, collectively the springs were measured over a number of years. The accompanying map shows the approximate depth to groundwater below the land surface. Line patterns approximately delineate zones within which the depth to groundwater is inferred to be > 500 ft. The areas delineated as possibly having depths to groundwater of > 500 ft are recognized as having potential for evaluating prospective environments for isolation of high-level nuclear waste in the unsaturated zone. (Lantz-PTT)
W89-06874

MAPS SHOWING GROUND-WATER LEVELS, SPRINGS, AND DEPTH TO GROUND WATER, BASIN AND RANGE PROVINCE, NEW MEXICO,
New Mexico Bureau of Mines and Mineral Resources, Socorro.
B. T. Brady, D. A. Mulvihill, D. L. Hart, and W. H. Langer.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 83-4118-B, 1984. 2p, 3 fig, 36 ref.

Descriptors: *Radioactive waste disposal, *Groundwater level, *Maps, *Springs, *Groundwater, *New Mexico, Groundwater budget.

This report was prepared as part of a program to identify prospective regions for further study relative to the isolation of high-level nuclear waste. Also included are selected references on pertinent geologic and hydrologic studies of the region. The groundwater levels and springs map shows the altitude of the groundwater level and the discharge and temperature of selected springs. The groundwater level map is a compilation of water level measurements taken over a number of years. However, for any one groundwater study area the measurements generally were made during a relatively short time period. Collectively, the groundwater levels show the regional configuration of the groundwater surface. Similarly, the reported values for individual springs were taken at one time; however, collectively the springs were measured over a number of years. The depth to groundwater map shows the approximate depth to groundwater below the land surface. Line patterns approximately delineate zones within which the depth to groundwater is inferred to be > 500 ft. These areas delineated as possibly having depths to groundwater of > 500 ft are recognized as having potential for evaluating prospective environments for isolation of high-level nuclear waste in the unsaturated zone. (Lantz-PTT)
W89-06875

MAPS SHOWING DISTRIBUTION OF DISSOLVED SOLIDS AND DOMINANT CHEMICAL TYPES IN GROUND WATER, BASIN AND RANGE PROVINCE, NEW MEXICO,
New Mexico Bureau of Mines and Mineral Resources, Socorro.
For primary bibliographic entry see Field 2K.
W89-06876

GEOHYDROLOGY OF THE GLACIAL-OUTWASH AQUIFER IN THE BALDWINSVILLE AREA, SENECA RIVER, ONONDAGA COUNTY, NEW YORK,
Geological Survey, Ithaca, NY. Water Resources Div.
T. S. Pagano, D. B. Terry, and A. W. Ingram.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, Co 80225. USGS Water Resources Investigations Report 85-4094, 1986. 7p, 10 fig, 20 ref.

Descriptors: *Maps, *Geohydrology, *Seneca River, *New York, *Glacial aquifers, Soil types, Sand, Gravel, Ice, Bedrock, Infiltration, Aquifers, Potentiometric level, Well yield, Land use, Groundwater budget.

Seven sheets of map data comprise this geohydrologic report. Sheet 1, surficial geology, illustrates the distribution of: open water areas; artificial fill; made land; urban land; alluvial silt and sand; alluvial sand and gravel; peat, marl, muck and clay; lake silt and/or clay; delta sand and gravel; beach sand and gravel; outwash sand and gravel; ice contact sand and ground; thick till cover bedrock; and thin till over bedrock over the Baldwinsville Area. Sheet 2, geologic sections, shows the layering of the aforementioned components below the surface layer. Sheet 3 illustrates the water infiltration of soil zone. Sheet 4 depicts the aquifer thickness. Sheet 5 illustrates the potentiometric surface, and Sheet 6 the well yield. Finally, Sheet 7 shows the land use in the region, specifically: industrial and extractive; commercial and services; transportation; farmland; forestland; residential; open public land; and water and wetlands. (Lantz-PTT)
W89-06877

BATHYMETRY OF LAKES MARION AND MOULTRIE, SOUTH CAROLINA,
Geological Survey, Columbia, SC. Water Resources Div.
G. C. Patterson, and S. W. Logan.
Available from Books and Open File Report Section, USGS, Box 25425, Denver, CO 80225. USGS Water Resources Investigations Report 88-4062, 1988. 2p, 7 fig, 8 ref.

Descriptors: *Bathymetry, *Mapping, *Lakes, *South Carolina, *Lake Marion, *Lake Moultrie, Santee-Cooper, Water depth, Contours, Maps, Reservoirs.

Lakes Marion and Moultrie are two large, interconnected reservoirs in the Coastal Plain of South Carolina. Bathymetric surveys during 1984-85 determined that, for the full-pool water surface elevation of 76.8 ft, the volume of Lake Marion is 1,425,000 acre-ft, and for the full-pool water surface elevation of 75.0 ft, the volume of Lake Moultrie is 1,060,000 acre-ft. These volumes are considered accurate to within 5%. Comparison with volumes determined in 1941, when the reservoirs were filled, shows decreased in volume of 73,000 acre-ft in Lake Marion and 30,000 acre-ft in Lake Moultrie. These changes in volume, however, are subject to relatively large possible error because they represent relatively small differences between relatively large volumes, and because the accuracy of the 1941 volumes is not known. Measurements of sediment inflow and outflow and of deposition rate suggest the volume losses were more likely about 29,000 acre-ft in Lake Marion and about 1,600 acre-ft in Lake Moultrie. The discrepancy in the estimate of volume changes does not affect the accuracy of the volume computation or the maps. (USGS)
W89-06880

STATISTICAL SUMMARIES OF STREAMFLOW RECORDS IN OKLAHOMA AND PARTS OF ARKANSAS, KANSAS, MISSOURI, AND TEXAS THROUGH 1984,
Geological Survey, Oklahoma City, OK. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06885

WATER RESOURCES OF THE ZUNI TRIBAL LANDS, MCKINLEY AND CIBOLA COUNTIES, NEW MEXICO,
Geological Survey, Las Cruces, NM. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06891

GROUNDWATER IN THE SOUTHEASTERN UINTA BASIN, UTAH AND COLORADO,
Geological Survey, Salt Lake City, UT. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06892

PROCEEDINGS, EIGHTEENTH MISSISSIPPI WATER RESOURCES CONFERENCE, 1988,
Mississippi State Univ., Mississippi State. Water Resources Research Inst.
For primary bibliographic entry see Field 6B.
W89-06899

HYDROGEOLOGY OF THE EDWARDS AQUIFER IN THE SAN ANTONIO AREA, TEXAS,
Geological Survey, San Antonio, TX. Water Resources Div.
For primary bibliographic entry see Field 2F.
W89-06914

GEOTOX: A KNOWLEDGE-BASED SURROGATE CONSULTANT FOR EVALUATING WASTE DISPOSAL SITES,
Lehigh Univ., Bethlehem, PA. Graduate School.
For primary bibliographic entry see Field 5E.
W89-06929

GROUNDWATER MAPPING: THE INFORMATION EXCHANGE BETWEEN MAP USERS AND MAP MAKERS,
Clark Univ., Worcester, MA. Dept. of Geography.
U. J. Dymon.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8608771. Ph.D. Dissertation, 1985. 281p, 88 fig, 46 tab, 83 ref, 2 append.

Descriptors: *Mapping, *Hydrologic maps, *Groundwater budget, *Groundwater management, *Surveys, Groundwater hydrology, Groundwater availability, Groundwater management, Model studies, Communication, Information exchange.

The communication linkages between map makers and map users during the initiation, development, and evaluation phases in the production of hydrological atlases (HA) were surveyed. A normative communication model representing an ideal communicative format was developed. The groundwater maps in the HA series chosen for the study are relatively new but widely-circulated and form one of the few broad-base integrated groundwater mapping efforts. Establishing the existence of gaps between the needs of the user and the producing agency (USGS) may yield useful guidelines for improving the effectiveness of the maps through redesign, content modification, or educational programs. Procedures also may be suggested by which the information exchange between map users and map makers can be restructured to ensure a more consistently useful product. (Cremmins-AEPCO)
W89-06961

8. ENGINEERING WORKS

8A. Structures

BENEFITS AND COSTS OF ALLOCATING SPACE IN AN EXISTING RESERVOIR TO RIVER REGULATION,

Ok Tedi Mining Ltd., Port Moresby (Papua New Guinea).
For primary bibliographic entry see Field 4A.
W89-05837

AIR CUSHION SURGE CHAMBERS FOR UNDERGROUND POWER PLANTS,
Norges Tekniske Hoegskole, Trondheim. Selskapet for Industriell og Teknisk Forskning.
For primary bibliographic entry see Field 8C.
W89-05896

DESIGNING UNLINED PRESSURE TUNNELS IN JOINTED ROCK,
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
For primary bibliographic entry see Field 8C.
W89-05897

CALAVERAS PROJECT HIGH HEAD PRESSURE TUNNEL,
Electrowatt Engineering Services Ltd., San Jose, CA.
For primary bibliographic entry see Field 8C.
W89-05898

GEOTECHNICAL CONSIDERATIONS FOR DESIGN OF THIN ARCH DAMS,
Army Engineer District, Jacksonville, FL. Geotechnical Branch.
W. T. Novak.
Bulletin of the Association of Engineering Geologists AEGBBU, Vol. 25, No 4, p 515-519, November 1988. 4 fig, 7 ref.

Descriptors: *Arch dams, *Dam design, *Dam foundations, *Rock properties, *Engineering geology, Deformation, Stress analysis, Puerto Rico.

The design of thin arch dams requires detailed knowledge of the foundations' deformation characteristics, as variations in the foundation deformation can affect the distribution of stress in the foundation rock which can in turn affect the stress distribution within the dam. This paper describes geotechnical investigations undertaken for a thin arch dam near Ponce, Puerto Rico. These investigations include centerline core borings and pressure tests, exploratory adits, in situ uniaxial jacking tests, rock mass classification, bore hole video logging, bore hole deformation tests (Goodman Jack), age-dating of faults and shears (potassium-argon dating), trenching of faults and extensive laboratory testing of rock and fault material. As a result of these investigations, the shearing resistance of the discontinuities within the foundation rock could be determined, and a method for determining a deformation modulus along the foundation axis of the dam was established. (Sand-PTT)
W89-05912

RECTANGULAR SHAFT CONFIGURATION FOR STORM SEWAGE OVERFLOW STRUCTURES,
Liverpool Univ. (England). Dept. of Civil Engineering.
R. Burrows, and K. H. M. Ali.
Proceedings of the Institution of Civil Engineers, Part 2 PCIEAT, Vol. 85, p 435-455, September 1988. 9 fig, 1 tab, 16 ref.

Descriptors: *Hydraulic geometry, *Sanitary engineering, *Storm wastewater, *Storm-overflow sewers, Sewer system, Stilling basins, Interceptor sewers, Outfall.

A form of overflow structure is presented which is appropriate to differential head applications in places where, for example, an interceptor sewer runs at depth beneath the level of the overspill pipe outfall. A configuration is presented which maximizes the chamber retention volume while keeping plan dimension compatible with those of conventional designs. The performance of this structure is verified by its improved particle retention efficiencies over a Sharpe-Kirkbride stilling pond chamber of similar dimensions, this being extensively employed in sewerage practice. Incorporation of storage provision in the chamber also leads to reduction in overspill occurrence. (Author's abstract)
W89-05997

HYDROPOWER PROJECT DESIGN INCORPORATING SUBMERGENCE COSTS,
Indian Inst. of Science, Bangalore. Dept. of Computer Science and Automation.
S. M. Lele, R. B. Norgaard, and D. K. Subramanian.
Journal of Environmental Management JEVMAW, Vol. 27, No. 3, p 307-323, October 1988. 2 tab, 26 ref, append.

Descriptors: *Hydroelectric power, *Project planning, *Submerged lands, *Cost-benefit analysis, Model studies, Siltation, Construction, India, Discount rate, Debt, Optimization.

A simple constrained optimization model is proposed for the benefit-cost analysis of large hydropower projects that considers submergence of land, siltation, delays in construction and heavy debt burdens. The model is then applied to two sites in India. Using the potential productivity of an energy plantation on the submergible land is suggested as a reasonable approach to estimating the opportunity cost of submergence. Optimum project dimensions are calculated for various scenarios. Results indicate that the inclusion of submergence cost may lead to a substantial reduction in net present value and hence in project viability. Parameters such as project lifespan, construction time, discount rate and external debt burden are also of significance. The designs proposed by the planners are found to be uneconomic, while even the optimal design may not be viable for typical scenarios. The concept of energy opportunity cost is useful for preliminary screening; some projects may require more detailed calculations. The optimization approach helps identify significant tradeoffs between energy generation and land availability. (Author's abstract)
W89-06006

COLLAPSING 96-INCH SEWER COMMANDS FAST CURE,
Metropolitan St. Louis Sewer District, MO.
J. F. Koeper, and L. E. Osborn.
Public Works PUWOAH, Vol. 119, No. 12, p 42-44, November 1988.

Descriptors: *Collapse, *Maintenance, *Rehabilitation, *Sewers, Tubes, Pipes, Deterioration, St. Louis, Hydrostatic pressure, Heat treatment, Economic impact, Cost analysis, Pipes, Tubes.

A quick and effective means of repairing infrastructure deterioration, employed by the Metropolitan St. Louis Sewer District is described. In July 1987, a damaged sewer invert beneath a busy street threatened temporary shutdown of one of the nation's largest breweries. The lack of underlying soil support, combined with traffic flow and soil weights, weakened the invert, causing a collapse capable of creating serious economic disruption. The pipe was reconstructed without disrupting flow, with a process involving the inversion of a special resin-impregnated felt tube through the damaged pipe, using hydrostatic pressure. The hydrostatic pressure pushed the tube forward while pressing it tightly against the irregular walls of the old, following the contours of the old sewer exactly, easily negotiating bends and changes in grade, and even spanning missing sections. After the tube was in place, it was heat cured until it formed a hard, structurally sound new pipe. Because it fit tightly against the existing brick pipe and had a smooth interior surface and no joints, flow capacity was increased. This choice proved to be wise in terms of cost effectiveness, time and disruption. (Miller-PTT)
W89-06007

PROGRESS AND PROSPECTS IN SOVIET HYDRO ENGINEERING,
For primary bibliographic entry see Field 8C.
W89-06209

DAM CONSTRUCTION AND HYDROPOWER DEVELOPMENT IN USSR,
Soviet Committee on Large Dams, Moscow (USSR).
S. I. Sadovsky.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 16-19, December 1988.

Descriptors: *Soviet Union, *Dams, *Hydroelectric power, *Electric power production, Regional development, Water resources development, Europe, Asia, Siberia, Hydroelectric plants.

The locations of major hydro schemes in the Soviet Union are described, special engineering activities are discussed, and hydropower development prospects to the year 2000 are reviewed. Some of the particular engineering challenges described here that have been met in Soviet hydro engineering are: composite dams on soft-soil foundations, concrete dams on rock foundations, arch dams, and embankment dams. Embankment dams have been preferred for areas of seismic activity. Utilization of hydro potential will soon reach 45% in the European USSR. For this reason future development is expected to be mainly in the far northern and southern regions of this territory and in the Asian part of the country. The restriction on suitable sites in Europe has led to increased use of small hydro plants in this area. The economically feasible potential of Siberia and the Far East exceeds 720 TWh, which represents about two-thirds of the total economically feasible hydro potential of the country. The hydropower resources of Siberia and the Far East are characterized by rivers abundant in water and having considerable falls, thus favoring the construction of large hydroelectric power stations. Overall, utilization of the hydropower resources in Siberia and the Far East could provide an annual growth of electric power totaling 183 TWh, with new installed capacities totalling about 43 GW. Hydropower development in Central Asia and Kazakhstan will provide for a total annual output of about 40 TWh, the total installed capacity of new hydropower plants representing 40 GW. (Rochester-PTT)
W89-06210

HEAD LOSS THROUGH POROUS DIKES,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 8B.
W89-06241

BRIEF INTRODUCTION TO THE REVELSTOKE PROJECT,
British Columbia Hydro and Power Authority, Vancouver.
For primary bibliographic entry see Field 8C.
W89-06242

FLOW ESTABLISHMENT IN HELICAL CORRUGATED PIPE,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W89-06246

MULTICRITERION ANALYSIS IN TECHNICAL-ECONOMIC CALCULATIONS OF HYDROPOWER AND WATER-MANAGEMENT FACILITIES,
For primary bibliographic entry see Field 6C.
W89-06266

FLOOD CONTROL STRUCTURES OF LENINGRAD,
A. P. Kosinskii, Y. M. Sevenard, S. N. Kuraev, and A. A. Vavilov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 92-96, August 1988. 5 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 21-24, February 1988.

Descriptors: *Flood protection, *Flood control, *Floodproofing, *Levees, *Dams, *Leningrad,

*USSR, Earth dams, Rockfill dams, Navigation canals, Water conveyance, Conveyance structures.

The plan developed in 1977 to protect Leningrad from flooding included a protective structure of 25,380 m extending across the Gulf of Finland from Gorskaya on the right shore across Kotlin Island to Lomonosov on the left shore, two navigation structures open for passage of ships and water with gates capable of being closed in thirty minutes, and six water-conveyance structures. The navigation and water conveyance structures are surrounded by 11 earth-rock levees. A management system was needed that would provide efficient coordination of the works of numerous organizations participating in creating the complex from the start of construction until putting the project into operation. The levees and navigation and water-conveyance structures are being constructed, a highway will be constructed on top of the dam, and work on amenities on the adjacent shores of the Gulf of Finland are to be completed. (White-Reimer-PTT)
W89-06267

INVESTIGATION OF THE STRESS-STRAIN STATE OF LOCK GATES ON A STRAIN-GAUGE MODEL,
V. S. Gavrish, V. F. Prostak, and V. N. Khimin.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 109-113, August 1988. 9 fig, 3 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 32-35, February 1988.

Descriptors: *Locks, *Gates, *Structural Models, Miter gates, Stress analysis, Stress, Strain, Stress-stain curves, Water stress, Strain-gauge model, Load distribution.

A strain-gauge model makes it possible to study the work of miter gates and to investigate the stress-strain state jointly or separately from the hydrostatic pressure and nonuniformity of support in the posts. Nonuniformity of support in the posts is related to the presence of gaps between the support pads, to the occurrence of a wedge-shaped gap in the miter post, and to spreading of the lock chamber walls during its filling with water and from seasonal temperature variations. Loading of the gates has a cyclic character not just due to the chamber filling and emptying cycles. The results show that during a rise (or drop) of the upper pool level not simply a monotonic change of beams and posts occurs in individual parts of the metal structures of the leaf, but additional cyclicity occurs. During elastoplastic deformation the prerequisites are created for the occurrence of cracks. The concentration of the rate of strain in regions abutting the flanges of the downstream horizontal beams to the posts is determined to a considerable extent by the initial construction of the section. (White-Reimer-PTT)
W89-06269

NEW TECHNOLOGICAL SOLUTIONS AND DESIGNS OF THE MECHANICAL EQUIPMENT OF STRUCTURES AT THE ROGUN HYDROELECTRIC STATION,
M. F. Krasilnikov, B. V. Bogomolov, Y. A. Antonov, and L. M. Shifrin.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 114-119, August 1988. 8 fig, Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 35-39, February 1988.

Descriptors: *Hydroelectric plants, *Power plants, *Radial gates, *Gates, USSR, Design criteria, Design standards, Technology, Structure, Structural engineering, Earth-rock dams, Erosion control, Tunnels, Equipment, Rogun Hydroelectric Station, Vakhsh Cascade.

The Rogun Hydroelectric powerplant site is in a deep, difficult to access canyon intersected by faults and subject to intense tectonic movements reaching 1-2 mm/yr. The main structures of the hydroelectric station include: a 335 m high rock-earth dam; underground structure of the powerhouse complex; temporary diversion tunnels; service outlet; and structures for protecting the salt bed from erosion. The discharges of up to 3760 cu m/sec during construction are conveyed by two 11 x 11 m tunnels. The total mass of the equipment and steel structural elements will be more than 50,000 tons and the calculated cost of the project will be at least 10 million rubles. A highly technologically efficient radial gate with sliding bearings made of wood-laminated plastic DSP-Bgt and a hydraulically controlled polyethylene seal was developed at the service gates capable of regulating discharges at head up to 200 m. In addition, vertical-lift sliding emergency-guard and guard gates on DSP-Bgt slides with hydraulic-acting polyethylene seals were developed. The high-head outlet works design required the consideration of using an upstream guard gate with a shut-off device. (White-Reimer-PTT)
W89-06270

EXPERIENCE OF ON-SITE INVESTIGATIONS OF THE CAVITATION EROSION OF HYDRAULIC TURBINES,
For primary bibliographic entry see Field 8C.
W89-06271

DESIGN, TECHNOLOGY OF MANUFACTURE AND INSTALLATION OF PRESTRESSED ANCHORS FOR SUPPORTING THE UNDERGROUND WORKINGS OF THE 'CHAIRA' PUMPED-STORAGE STATION.
L. Popova.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 126-131, August 1988. 7 fig. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 48-53, February 1988.

Descriptors: *USSR, *Anchors, *Pumped storage, *Prestressed anchors, Design criteria, Design standards, Technology, Manufacturing, Installation, Chaira pumped-storage station.

The Chaira pumped storage station design imposed the following requirements on deep prestressed anchors of the machine hall: depth of installation 20 m; bearing capacity under operating load of 120 tons and under a check load of 160 tons; presence of reliable corrosion protection ensuring a service life of at least 59 years; possibility of regulating the tensile stress in case the values of the check load are exceeded as a result of stress relief of the rock mass; sufficient flexibility of the anchors allowing assembly in tunnel workings with a diameter up to 4.5 m. The technology of manufacturing the anchors calls for cleaning rust from the wire ropes with Ikosite, cement grout and Anticorin, and protecting the metal parts of the anchor against long-term underground conditions. In assembling the anchor primary attention is paid to a tight connection of the separating packer with the bundle of ropes and pipes. Observations of the behavior of the anchors are carried out by means of dynamometers mounted on them. Minimum changes have been recorded in the force of tension in the roof and an increase of this force up to 15 tons in parts of the walls of the machine hall. (White-Reimer-PTT)
W89-06273

THREE-EMBANKMENT DAMMING OF THE DIVERSION CANAL AT THE CONSTRUCTION SITE OF THE HOA BINH HYDRO DEVELOPMENT IN VIET NAM,
P. T. Bogachenko, O. M. Bachillo, I. M. Bachillo, and T. P. Nhe.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 131-137, August 1988. 7 fig. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 52-55, February 1988.

Descriptors: Dams, *Rockfill dams, *Dam construction, *Dam design, *Hydroelectric plants, *Diversion channels, *Viet Nam, Multiembankment dams, Canals, Hoa Binh Hydro Project, Da River.

The damming of the diversion canal with the transfer of the river discharges to diversion tunnel No. 2 on January 9, 1986 completed one of the main stages in the construction of the hydro development on the Da (Black) River. Hydraulic investigations were preliminarily conducted on a model with consideration of the conditions at the construction site at the time of damming and prediction of the discharges expected on these days. Discharges within limits from the design to the probable were taken into account in the investigation, and the maximum velocities and fall on the embankments and the amount of necessary fill materials were determined. These investigations established that the design width of the cut in the cofferdams, equal to 100 m, could be reduced by 20%. Based on the results of this project it can be concluded that when selecting the damming scheme, preference should be given to a multiembankment scheme. The advantages over the one-embankment are a reduction of the damming time and savings of construction materials, especially concrete tetrahedra. In addition, with an appropriate fall and number of damming sites it is also possible to use only rock mass and outsizes. The multiembankment scheme of damming can be recommended when the axes of the embankments are not less than 200 m apart for any design discharge and fall. (White-Reimer-PTT)
W89-06274

AXIAL DILUTION IN OBSTRUCTED ROUND BUOYANT JET,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
For primary bibliographic entry see Field 8B.
W89-06278

BIG RESERVOIRS LINED IN DAYS,
Rainbow Municipal Water District, Fallbrook, CA.
J. Perry, and D. Martinson.
Water Engineering and Management WENMD2, Vol. 135, No. 12, p 44-45, December 1988.

Descriptors: *Reservoir linings, *Maintenance, *Installation, Reservoirs, Vegetation, Asphalt, Plastics, Polymers, Excavation, Leakage, Water districts, California.

The Rainbow Municipal Water District in Southern California, serving a large portion of San Diego County, installed new, one-piece liners in two large reservoirs in just over a week. Lining the reservoirs with asphalt would have required taking them out of service for three months. Moreover, the large amount of vegetative growth required a continuous and impregnable liner. Therefore, the district selected 80-mil high-density polyethylene as the liner material. With this material, separate sheets can be fused together to seam the joints. The district used up the water in the Bonsall Reservoir and then removed the existing liner within three days. Installation and testing of the new liner (95,000 square feet) took only five days. The North Reservoir was then renovated and relined (72,000 square feet) in the same period of time. Both reservoirs are back in use, with no loss in service to Rainbow's customers, and with significant water savings brought about by eliminating the leakage that had been taking place. (Doria-PTT)
W89-06549

WORKSHOP DESIGN FOR RAINWATER ROOF CATCHMENT SYSTEMS: A TRAINING GUIDE,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 3B.
W89-06602

WORKSHOP DESIGN FOR SPRING CAPPING: A TRAINING GUIDE,
Water and Sanitation for Health Project, Arlington, VA.
For primary bibliographic entry see Field 4B.
W89-06603

WAX LAKE OUTLET CONTROL STRUCTURE ATCHAFALAYA RIVER: HYDRAULIC MODEL INVESTIGATION FINAL REPORT,
Army Engineer Waterways Experiment Station, Vicksburg, MS. Hydraulics Lab.

C. R. Nickles, and T. J. Pokrefke.
Available from the National Technical Information Service, Springfield, VA 22161. Waterways Experiment Station Technical Report HL-88-29, November 1988. 50p, 1 fig, 7 tab, 27 plates.

Descriptors: *Check structures, *Hydraulic structures, *Outlets, *Atchafalaya River, *Louisiana, *Hydraulic models, Flow control, Slope stability, Flow velocity, Dams, Wax Lake, Flow discharge, Leaves.

This investigation was concerned with the development of plans for a stone control structure in Six Mile Lake to maintain a flow distribution of 70% down the Atchafalaya River toward Morgan City, LA, and 30% down Six Mile Lake to the Wax Lake Outlet channel for nonflood periods, < 550,000 cfs Atchafalaya Basin discharge. The study indicated that the desired flow distribution could be obtained with a stone structure in Six Mile Lake connected to the West and South Protection Levees by earthen overflow levees. The stone structure began at the right bank end of the earthen levee, sta 17+00, extended for 332.5 ft at el 11.3 with a 30-ft crown, sloping down at 1V on 10H to el 7.5, continuing at el 7.5 with a 30-ft crown for 1,100 ft, sloping down to el -2.0 at sta 32+00.5, continuing for 1,100 ft at el -2.0 with a 10-ft crown, sloping up to el 11.3, continuing at el 11.3 with a 30-ft crown for 345.5 ft to tie in to the earthen Cypress Island cutoff levee. The stone structure had side slopes of 1V on 3H on the upstream face and 1V on 4H on the downstream face. Stability berms that extended 181.5 ft upstream and 200 ft downstream of the axis of the structure were placed at el -5.0. The earthen levee on the right bank was constructed at el 11.3 and the levee on Cypress Island was constructed at el 10.8. This structure produced flow distributions ranging from 27% at the lower flows to about 35% for flows near 550,000 cfs. Velocities ranged from about 12 ft/sec in the notch to 9 ft/sec 1,000 ft below the axis of the structure. This was the nearest to the desired 70-30% distribution with the lowest velocities of all plans tested. (Author's abstract)
W89-06664

STATISTICAL QUALITY CONTROL OF ENGINEERED EMBANKMENTS,
Nexus Associates, Wayland, MA.
For primary bibliographic entry see Field 8D.
W89-06666

STRUCTURES IN THE STREAM: A HISTORY OF WATER, SCIENCE, AND THE CIVIL ACTIVITIES OF THE U.S. ARMY CORPS OF ENGINEERS, 1700-1861,
Carnegie-Mellon Univ., Pittsburgh, PA. Coll. of Humanities and Social Sciences.
For primary bibliographic entry see Field 6E.
W89-06967

8B. Hydraulics

FUNDAMENTAL INVESTIGATION OF GRAVITY CURRENTS WITH VARYING DENSITY,
Texas Univ. at Dallas, Richardson. Graduate Program in Environmental Sciences.
For primary bibliographic entry see Field 2H.
W89-06060

CALCULATION OF THE DEPTH OF SCOUR IN ROCK DOWNSTREAM OF A SPILLWAY,
T. H. Akhmedov.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 25-27, December 1988. 1 fig, 2 tab, 19 ref.

Descriptors: *Scour, *Spillways, *Rock properties, *Erosion, Mathematical analysis, Design criteria, Abrasion, Pakistan, Canada, Bed load.

A method is described for determining the depth of river bed scouring caused by spillway discharge and it is applied at two sites, Tarbela Dam, Pakistan, and on the Stikine River, Canada. Initially, flow volume will break off fragments of rock. As scour pit depth increases, the flow velocity near the bed decreases, until a point is reached when this form of erosion ceases. The development of the scour pit is divided into three phases: (1) direct removal of rock fragments, (2) dislodgement of rock fragments under hydrodynamic forces, and (3) grinding of loose rocks against each other with the smaller ones being carried away by the flow (abrasive phase). At the Tarbela Dam, where rocks are metamorphosed limestones, the difference between the actual and the calculated scour depth ranged from -4.53 to 23.8%. Comparable figures for the Stikine River were -40.6 to 34.5%. (Negative values mean that calculated values exceeded actual values.) (Rochester-PTT)
W89-06211

REJECTION BORES IN RECTANGULAR POWER CANALS,
Detroit Water and Sewerage Dept., MI.
M. A. Gill.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 38,40-42, December 1988. 2 fig, 1 tab, 3 ref.

Descriptors: *Bores, *Waves, *Switching surges, *Hydraulic engineering, *Head flumes, *Shock loads, *Hydroelectric plants, Mathematical analysis, Slope, Canals.

When electrical load is suddenly rejected, one or more turbines at a hydro plant may go out of operation. The total discharge water going through the turbines is thus suddenly reduced, or even becomes zero, when load is completely rejected. Such abrupt changes in discharge lead to the formation of surges in a power canal; these are termed rejection bores. Bores are groups of waves that travel together at the same speed. They also are called positive surges in the hydraulic literature, whereas surges that form upon sudden acceptance of load are called negative surges. Direct approximate solutions are presented for computing the characteristics of rejection bores in sloping canals. Two examples are solved using a 1.609-km channel of rectangular section 9.14-m wide, with a Manning value of 0.014, a bed slope of 0.0002, and delivering 28.3 cu m/sec to the headworks of a power plant. (Author's abstract)
W89-06213

SIMPLIFIED PROCEDURE TO EVALUATE LIQUID COLUMN SEPARATION PHENOMENA,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
R. Carmona, J. L. Sanchez, and L. Carmona.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 42-46, December 1988. 6 fig, 17 ref.

Descriptors: *Cavitation, *Column separation, *Penstocks, *Hydraulic engineering, *Air entrainment, *Mathematical analysis, *Surges, Hydroelectric plants, Valves, Pipelines, Hydrodynamics, Mexico, Water pressure.

Several procedures are available for evaluating liquid column separation phenomena in horizontal penstocks. Some are quite complicated and offer quite accurate results; others are rather simple, but give results that are to approximate. It is shown that, with some slight modifications, it is possible to employ the well-known method of characteristics for analyzing liquid column separation problems. For transient pressure surges, it was found that during the first three steps (each step includes first a positive wave and then a negative wave) after a valve is suddenly closed, the results evaluated using the proposed method agree well with laboratory measurements, both in magnitude and time. The procedure has been applied to water column separation confined at any end of a pipeline, but it can be used to evaluate column separation pressures produced either by combined evaporation-air release or by air inclusion. The method was used to compute water column separation at the upstream ends of the Rio Uspanapa pumping plant, Veracruz, Mexico, and Armeria-Manzanillo pumping plant, Colima, Mexico. (Rochester-PTT)
W89-06214

HEAD LOSS THROUGH POROUS DIKES,
Iowa Univ., Iowa City. Dept. of Civil and Environmental Engineering.
S. C. Jain, F. M. Holly, and T. H. Lee.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 766-775, October 1988. 10 fig, 15 ref.

Descriptors: *Dikes, *Dams, *Rockfill dams, *Fish barriers, *Powerplants head loss, Cooling ponds, Scale model tests, Porous media, Reynolds number, Velocity, Friction, Friction loss, Flow friction, Commonwealth Edison, LaSalle County, Illinois.

Porous dikes have been proposed for use in blocking access of fish to cooling water intakes in power plants using large cooling ponds for heat dissipation. The full-scale experiments on the porous-dike material proposed for Commonwealth Edison's LaSalle County power plant confirmed the non-Darcy, non-quadratic head-loss characteristics of porous-dike flow, and confirmed the dependence of the friction factor on both the Reynolds number and in-place material properties. A new variable-gradient procedure was developed for determination of the bulk head-loss coefficient, velocity exponent, and friction factor for the experimental tests. The velocity exponent n was found to be 1.72 for both the loose and compact 30.5 cm riprap stone dikes, and parameter theta (shape factor to the 1/2 power /dimensional empirical parameter) was 0.46 s/m to the 1/2 power for the loose dike and 0.38 s/m to the 1/2 power for the compact dike. Limited schematic tests on the effect of dike clogging by floating debris indicated an additional Reynolds-number-dependent head-loss coefficient from 0.3 to 1.6. (White-Reimer-PTT)
W89-06241

HEAD LOSSES AT MANHOLES WITH A 90 DEGREE BEND,
National Water Research Inst., Burlington (Ontario). Rivers Research Branch.
J. Marsalek, and B. J. Greck.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 851-858, October 1988. 2 tab, 4 fig, 6 ref.

Descriptors: *Sewer systems, *Head loss, *Closed conduit flow, *Pipe flow, *Flow resistance, Pipelines, Manholes.

Head losses are affected by the flow velocity, manhole geometry, and the type of flow. Losses increase linearly with the velocity head and the coefficient of proportionality is defined as the head loss coefficient. Because the changes in the flow cross-sectional area and direction encountered at these manholes are greater for surcharged flows than for open-channel flows, the head losses at surcharged manholes are also greater. Among the geometrical parameters of surcharged manholes with a 90 degree bend and no change in pipe diameter, the benching had the most pronounced effect on the head loss, followed by the relative manhole size (width), and the base shape. The lowest head losses were found for a design with full-pipe depth benching of increased width. The observed head losses were barely sensitive to the variations in the relative manhole size tested, but smaller manholes deflected better flow into the outfall and produced somewhat smaller head losses. The losses observed for square and round base manholes were almost identical. By increasing the outfall diameter, the head loss coefficients can typically be reduced by 5-19%. (White-Reimer-PTT)
W89-06245

FLOW ESTABLISHMENT IN HELICAL CORRUGATED PIPE,
Saskatchewan Univ., Saskatoon. Dept. of Civil Engineering.
C. D. Smith.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 912-915, October 1988. 1 tab, 3 fig, 6 ref.

Descriptors: *Head loss, *Pipes, *Pipe flow, *Flow, *Pipelines, *Flow characteristics, Flow friction, *Flow resistance, Flow velocity, Flow pattern, Flow rates, Helical corrugated pipe, Corrugated pipe.

Helical-corrugated steel pipe does not have the same head loss characteristics as circular corrugated pipe. Model pipes 107 mm inside diameter and 2.13 m long were used to determine the development head loss. Standard corrugations were simulated and helix angles of 61.0 and 71.4 degrees were tested. About 12 diameters of pipe length were required to obtain fully established flow, and a value for the development head loss of 0.2 times the velocity head was indicated. This loss should be added to the other losses in the system, calculated in a conventional manner, to find the total head loss. (White-Reimer-PTT)
W89-06246

TWO-DIMENSIONAL STEADY STATE UNSATURATED WATER FLOW IN HETEROGENEOUS SOILS WITH AUTOCORRELATED SOIL HYDRAULIC PROPERTIES,
Agricultural Univ., Wageningen (Netherlands). Dept. of Hydraulics and Catchment Hydrology.
For primary bibliographic entry see Field 2G.
W89-06257

CONSIDERATION OF BANK STORAGE WHEN DETERMINING THE POWER OUTPUT OF A HYDROELECTRIC STATION,
A. Y. Aleksandrovskii, and N. K. Litvin.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 81-84, August 1988. 1 tab, 1 fig, 5 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 14-16, February 1988.

Descriptors: *Power stations, *Hydroelectric plants, *Storage reservoirs, *Bank storage, *Storage capacity, *Reservoir storage, *Design criteria, Mathematical analysis, Mathematical equations, Mathematical studies, Safety, Surface water, Subsurface water, Groundwater, Regulated flow, USSR.

The interaction of surface and subsurface waters resulting in increasing streamflow regulation is not taken into account in the practice of designing hydrostations. The effect of this interaction depends on the hydrogeological parameters of the water-bearing rocks (permeability coefficient, hydraulic diffusivity, storage coefficient, etc.). The dynamics of groundwaters in such a formulation corresponds to a free-surface, unsteady, nonuniform seepage flow. The proposed method of taking this interaction into account using mathematical formulations aided by computers, makes it possible to estimate the effect of the indicated factor on any planned hydropower facility. In the general case the problem reduces to the solution of a nonlinear differential equation of three-dimensional seepage flow. A preliminary evaluation of taking into account the effect of the interaction of surface and subsurface waters for the example of a hydrostation with a seasonal reservoir made it possible to estimate the effects with respect to an increase of firm capacity within 0.4-0.9% and with respect to an increase of useful storage of the reservoir within 3-6%. This refinement should be added to the margin of safety of the power indices of the planned hydrostation. (White-Reimer-PTT)
W89-06265

ROUGHNESS COEFFICIENT IN RIVER CHANNELS,
A. Gavor, and E. Ratomski.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 124-125, August 1988. 3 fig, 1 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 47-48, February 1988.

Descriptors: *Roughness coefficient, *Channel morphology, *Hydraulic friction, *Hydraulic roughness, *River flow, *Flow characteristics, *Flow measurement, *Flow resistance, Chezy equation, Strickler equation, Miller equation, Gladki-Gavor equation, Poland equation, Poland, Raba River, Wisla River.

One of the parameters necessary for calculating the hydrodynamics of natural channels is the Chezy roughness coefficient. The most frequently used formulas for determining the coefficient are the Strickler, Miller, Gladki-Gavor, and Poland. The values of the average velocity differ considerably depending on the formula used for calculating the coefficient. Due to the differences in the results depending on which formula was used, measurements were taken for different stages and discharges for five rivers in southern Poland. A comparison of the actual measurements with the calculated values indicates the Gladki-Gavor formula for calculating the Chezy roughness coefficient is the closest to the actual measurements for the streams. (White-Reimer-PTT)
W89-06272

OCEAN OUTFALLS. I: SUBMERGED WASTEFIELD FORMATION,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-06275

OCEAN OUTFALLS. II: SPATIAL EVOLUTION OF SUBMERGED WASTEFIELD,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-06276

OCEAN OUTFALLS. III: EFFECT OF DIFFUSER DESIGN ON SUBMERGED WASTEFIELD,
Georgia Inst. of Tech., Atlanta. School of Civil Engineering.
For primary bibliographic entry see Field 5E.
W89-06277

AXIAL DILUTION IN OBSTRUCTED ROUND BUOYANT JET,
National Technical Univ., Athens (Greece). Dept. of Civil Engineering.
G. C. Noutsopoulos, and P. C. Yannopoulos.
Journal of Hydraulic Engineering JHEND8, Vol. 115, No. 1, p 71-81, January 1989. 1 tab, 5 fig, 14 ref, append.

Descriptors: *Hydraulic models, *Wastewater dilution, *Wastewater disposal, *Wastewater outfall, *Ocean dumping, Plumes, Jets.

Experimental results concerning the axial concentration (or dilution) distribution of a round vertical turbulent buoyant jet of fresh water, discharged in a calm ambient saline solution and obstructed by a thin concentric disc of diameter D, placed horizontally at a distance H from the jet exit section of diameter d verify the effectiveness of the disc in increasing dilutions in the region behind the disc compared to the unobstructed buoyant jet. Thus the disc arrangement may prove useful in engineering practice in the design of diffuser systems at the end of submarine conduits used to discharge sewage effluents. Within the range of the parameters D/d and H/D tested, it was found that D/d was not a significant one, while H/D primarily affects the concentration distribution behind the disc. The functional relationship concerning the axial concentration distribution behind the disc is well established quantitatively on the basis of experiments and well verified. (White-Reimer-PTT)
W89-06278

EFFECT OF SEDIMENT DENSITY ON BED-LOAD TRANSPORT,
Ministry of Works and Development, Christchurch (New Zealand). Hydrology Centre.
For primary bibliographic entry see Field 2J.
W89-06281

COMPREHENSIVE GENERALIZED STUDY OF SCOUR AT CANTILEVERED PIPE OUTLETS: PART I. BACKGROUND,
Agricultural Research Service, Stillwater, OK. Water Conservation Structures Lab.
F. W. Blaisdell, and C. L. Anderson.
Journal of Hydraulic Research JHYRAF, Vol. 26, No. 4, p 357-376, 1988. 8 fig, 34 ref.

Descriptors: *Spillways, *Flood protection, *Scour, *Pipe outlets, Cantilevers, Pipe, Hydraulic design.

Criteria have been developed for the design of riprapped cantilevered pipe spillway plunge pool energy dissipators having the shape of self-formed scour holes. A literature review revealed information on the general principles of local scour at pipe exits, but inadequate practical information on scour and prevention of scour at pipe outlets. A research plan was devised to provide the needed information, and experimental apparatus and instrumentation were developed to investigate the scour process. Scour hole shape, including its variation with discharge, progression with time, and suspended-material-removed tests, was studied as was the phenomenon of 'beaching'. Equations were developed to define the path of properties of the jet issuing from the cantilevered pipe and the bed of the scour hole. The jet velocity accelerates and its average diameter velocity accelerates and its average diameter decreases until the jet plunges into the tailwater. As a result, it is the jet plunge velocity and plunge diameter that govern the scour. (Brock-PTT)
W89-06397

COMPUTATION OF CRITICAL DEPTH IN SYMMETRICAL COMPOUND CHANNELS,
Washington State Univ., Pullman. Dept. of Civil and Environmental Engineering.
For primary bibliographic entry see Field 2E.
W89-06398

PREDICTION OF FLOW CHARACTERISTICS IN MAIN CHANNEL/FLOOD PLAIN FLOWS,
Monash Univ., Clayton (Australia). Dept. of Civil Engineering.
For primary bibliographic entry see Field 7C.
W89-06400

LABORATORY EXPERIMENTS ON RESISTANCE TO OVERLAND FLOW DUE TO COMPOSITE ROUGHNESS,
Katholieke Univ. Leuven (Belgium). Lab. voor Experimentele Geomorfologie.
For primary bibliographic entry see Field 2J.
W89-06510

MULTIPLY-CONNECTED CHANNEL MODE OF TIDES AND TIDAL CURRENTS IN PUGET SOUND, WASHINGTON AND A COMPARISON WITH UPDATED OBSERVATIONS,
National Oceanic and Atmospheric Administration, Seattle, WA. Pacific Marine Environmental Lab.
For primary bibliographic entry see Field 2L.
W89-06632

EFFECT OF PRESSURE FLUCTUATIONS ON PIPE FAILURE IN WATER DISTRIBUTION SYSTEMS,
Akron Univ., OH. Graduate School.
K. E. Mehrfar.
Available from University Microfilms International, 300 N. Zeeb Road, Ann Arbor, MI 48106, Order No. 8704727. Ph.D. Dissertation, 1987. 130p, 11 fig, 15 tab, 23 ref, append.

Descriptors: *Pipes, *Computer models, *Model studies, *Rupturing, *Water distribution, Simulation analysis, Hydraulic models, Pressure distribution, Pressure conduits, Stress analysis, Computer programs, Water conveyance.

An interactive pipe break model for the study of the effects of pressure fluctuations on pipe failure in water distribution systems was developed and tested. The model consists of a Pipe Break Program and a Hydraulic Analysis Program. The Pipe Break Program was developed to determine break patterns at a specified location in the system. The results obtained from that program are then cou-

pled with results from the Hydraulic Analysis Program, which dynamically simulates the cyclic pressure changes the distribution system goes through during daily operations. Test applications of the model showed a clear correlation between areas of high stress concentrations and the occurrence of pipe breaks reported and documented by the maintenance division of a water department. Although the model proved effective in two applications, its use is limited by: (1) A maximum of 15,000 pipes and 15,000 nodes can be analyzed by the continuous simulation portion of the model; (2) It can be utilized only on large mainframe or mini-computers with virtual operating system capability; (3) Execution of the model requires the use of a graphics terminal and a plotter or an electrostatic copier; (4) Extensive pipe break records are required for the Pipe Break Model. (Cremmins-AEPCO)
W89-06938

8C. Hydraulic Machinery

ULTRA HIGH HEAD UNITS FOR FRANCE'S SUPER BISSORTE PUMPED-STORAGE PLANT,
Electricite de France, Chambery.
Q. M. Truong, Y. Bouvet, and C. Periolat.
International Water Power and Dam Construction, Vol. 40, No. 11, p 11-16, November 1988. 6 fig, 7 ref.

Descriptors: *Pump turbines, *Hydraulic engineering, *Pumped storage, *Hydroelectric plants, *France, Hydraulic design, Ultra high head units.

Recent technological progress, including the use of advance computational tools and an increased knowledge of flow behavior within turbines, has led to the development of pump turbines to operate under heads of up to 1200 m. Super Bissorte is in the North Alps near the boundary between France and Italy. It is on the left bank of the Bissorte torrent, an affluent of the Arc river. It includes two existing reservoirs which are 3.1 km apart with a difference in elevation of about 1160 m. this L/H ration of 2.7 makes this plant very economical. The upper reservoir is known as Bissorte, and has an effective capacity of 39 million cu m at el.2082; the lower reservoir is called Pont des Chevres, with a capacity of 1.2 million cu m at el.923. The main civil structures of the scheme include: a water intake at the upper reservoir; a headrace tunnel; a penstock in an inclined shaft; two underground powerhouses; and tailrace tunnels with lower reservoir outlet structures. Almost all the structures have been built underground in compact altered sandstone of good quality, mixed with conglomerate and thin black slate. The first unit has now operated since June 1987, and the results obtained confirm the validity of the designs. Technological improvements, exhaustive studies undertaken with the most recent computational tools and a better knowledge of the flow within the turbines has led to the evolution of these ultra-high head multi-stage pump-turbines without wicket gates. An increase in head from 930 to 1200 m has been achieved, and an increase in output from 80 to 150 MW. This evolution shows that for both the single-stage adjustable pump-turbines and for multi-stage pump-turbines it is possible, on the basis of present knowledge and on the experience of existing pump-turbines, to envisage the production of more powerful units under guaranteed safety conditions. (Author's abstract)
W89-05893

OHKAWACHI PUMPED-STORAGE SCHEME IN JAPAN,
Japanese National Committee on Large Dams, Osaka.
M. Nose, and N. Kondo.
International Water Power and Dam Construction, Vol. 40, No. 11, p 17-21, November 1988. 12 fig.

Descriptors: *Pump turbines, *Hydraulic engineering, *Pumped storage, *Hydroelectric plants, *Hydraulic design, *Japan.

The 1280 MW Ohkawachi pumped-storage project, now under construction in Japan, will be the largest pure pumped-storage scheme in the country. The main purpose of the adjustable-speed pumped-storage system, adopted (for the first time) for two of the four units in this project, is to achieve a better control and stabilization of the power system frequency in the pumping mode, and an improvement in the generating mode efficiency, and, thus, more economical operation of the whole system. In deciding the size of the plant, the possibility of making the upper and the lower reservoirs as large as possible had to be considered carefully. Larger reservoirs would have made the scheme more attractive; however, because of some serious difficulties of topography and geology, the available storage capacity of 8260 million cu m for the lower reservoir had to be accepted. The maximum generation discharge of 382 cu m was decided on the basis of the available storage capacity of the reservoirs and the peak power demand duration of 6 h a day. The maximum installed capacity of the plant was determined as 1280 MW, by assuming design reservoir levels at 795.9 m for the upper basin and 388.9 m for the lower one. The upper reservoir will be formed by five dams, all of the rockfill type with impervious central cores. Their heights will range from 23.5 to 55.5 m. The lower reservoir dam is of the concrete gravity type and will be 102 m high. The reservoirs will be connected by two penstocks each about 700 m long, and four tailrace tunnels each about 400 m long. (Author's abstract)
W89-05894

PERFORMANCE OF THE CAPLJINA PUMP-TURBINES,
Hydroart S.p.A., Milan (Italy).
G. Beducci, and F. Vesligaj.
International Water Power and Dam Construction, Vol. 40, No. 11, p 22-27, November 1988. 12 fig, 2 tab.

Descriptors: *Pump turbines, *Hydraulic engineering, *Pumped storage, *Hydroelectric plants, Yugoslavia, Hydraulic design, Model studies.

During the nine years of operation of the Capljina pumped-storage plant, the total energy production of the two units from water already contained in the upper reservoir has reached about 750 GWh/year, while the yearly maximum production of the two units from pumped storage has been more than 230 GWh. This energy has mainly been used by northern regions of Yugoslavia and some has been exported. Each unit has been working for a yearly maximum of more than 2300 h as a turbine and more than 800 h as a pump. However, the hours of operation as a synchronous condenser have been much fewer. The spherical valves of this plant have reached a peak of 400 operations in one year, in both the generating and pumping modes. The experience gained with direct-on-line asynchronous startups has proved totally satisfactory and can be extended without problems to any other large sized pumped-storage scheme. Apart from some unavoidable problems, solved at the commissioning stage or during the early period of operation, no significant interruption has ever occurred in a long period of operation. Little maintenance has been required and this has been limited to components of secondary importance. (Author's abstract)
W89-05895

AIR CUSHION SURGE CHAMBERS FOR UNDERGROUND POWER PLANTS,
Norges Tekniske Hoegskole, Trondheim. Selskapet for Industriell og Teknisk Forskning.
D. C. Goodall, H. Kjorholt, T. Tekle, and E. Broch.
International Water Power and Dam Construction, Vol. 40, No. 11, p 29-34, November 1988. 11 fig, 4 tab, 14 ref.

Descriptors: *Surge, *Underground powerplants, *Hydraulic engineering, *Hydroelectric plants, *Surge chambers, *Norway, Air cushions.

Nine air cushion surge chambers in essentially unlined rock have been commissioned in Norway since the concept was introduced in the early 1970s. They have been used for headrace tunnel lengths of up to 13 km. Six of the 9 installations have functioned satisfactorily as constructed. At 2 sites, remedial work has been necessary to reduce air loss. Where the water pressure in the rock mass surrounding an air cushion exceeds the air pressure, air loss will be the result of dissolution only and will be minimal. Otherwise leakage through the rock mass will dominate the air loss: rock masses with permeabilities greater than about 1 sq femtometer have required the use of grouting or a water curtain to respectively reduce or eliminate leakage through the rock; rock masses with permeabilities less than about 1 sq femtometer have experienced acceptable air loss in their as-excavated state. (Author's abstract)
W89-05896

DESIGNING UNLINED PRESSURE TUNNELS IN JOINTED ROCK,
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
L. Ming, and E. T. Brown.
International Water Power and Dam Construction, Vol. 40, No. 11, p 37-41, November 1988. 6 fig, 16 ref.

Descriptors: *Hydroelectric powerplants, *Tunnel construction, *Pressure conduits, *Construction joints, Tunnel linings, Shear stress, Jointed rock, Mathematical analysis, Geologic mapping, In situ tests.

The design approach for unlined pressure tunnels described here explicitly takes in to account the effects of jointing in the rock and the in-situ stress field. Design charts for use in preliminary design are prepared from analytical solutions. A numerical method for use in detailed analysis simulates 3 major modes of unlined pressures tunnel failure: hydraulic jacking of joints; hydraulic shearing of joints; and, uplift of the ground surface. Geological mapping, in-situ testing and monitoring are vital components of the design approach proposed. The studies suggest that the following guidelines should be satisfied if a pressure tunnel in jointed rock is to remain unlined: The rock should be strong and massive with a high intact tensile strength and low permeability; minimum cover thicknesses determined by traditional means may provide unreliable measures of the need for remedial measures. The relationships between the in-situ stresses and the discontinuities in the rock mass are more likely to exert the controlling influence. Relatively high values of lateral in-situ stresses are favored, if these are low, hydraulic jacking is likely to occur in steep and inclined joints at low tunnel water pressures. To avoid hydraulic shearing, suitable treatment is required to prevent water under pressure from entering the joints; all joints which intersect the unlined tunnel boundary and are filled with erodible materials should be treated to prevent erosion and consequent increases in permeabilities and decreases in strengths of the joints. (Author's abstract)
W89-05897

CALAVERAS PROJECT HIGH HEAD PRESSURE TUNNEL,
Electrowatt Engineering Services Ltd., San Jose, CA.
P. Johannesson, A. Schleiss, and G. Korbin.
International Water Power and Dam Construction, Vol. 40, No. 11, p 43-48, November 1988. 7 fig, 8 ref.

Descriptors: *Hydroelectric powerplants, *Tunnel construction, *Pressure conduits, *California, Rivers, High head pressure tunnel, Cost analysis.

Considerable cost savings were achieved during the construction of the Calaveras high head pressure tunnel in the California. The use of a staged approach to the geotechnical investigations was most efficient and cost effective. Major decisions based on the surface work included the elimination of the liner at Mill Creek and confirmation of the underground alternative for the high pressure conduit. The refinements made possible by the underground investigations included a 12% reduction in steel liner length (116 m shorter). Using drainage

valves for external water pressure resulted in an additional 40% reduction in steel weight over more conventional approaches. Further savings were achieved by full application of load sharing, whereby up to 79% of the internal pressure is taken by the rock. Total savings as a result of the above were in excess of 6 million dollars. (Author's abstract)
W89-05898

ELECTROMECHANICAL EQUIPMENT FOR CZECHOSLOVAKIA PUMPED-STORAGE PLANTS,
CKD Blansko (Czechoslovakia).
V. Odvarko.
International Water Power and Dam Construction, Vol. 40, No. 11, p 50-57, November 1988. 4 tab.

Descriptors: *Pump turbines, *Hydraulic engineering, *Pumped storage, *Hydroelectric plants, Czechoslovakia, Hydraulic design.

Newly developed materials, improvements in the design of guidevanes, and a specially developed synchronizing circuit are some of the recent achievements in the field of pumped-storage machinery in Czechoslovakia. The state-of-the-art of Czech pump-turbine technology is reviewed emphasizing the automated control centers at Dalesice, Cierny Vak and Dlouhe Strane. (Author's abstract)
W89-05899

PROTECTING A WATER SYSTEM AGAINST BACKFLOW,
United McGill Corp., Columbus, OH.
For primary bibliographic entry see Field 5F.
W89-05918

PROGRESS AND PROSPECTS IN SOVIET HYDRO ENGINEERING,
A. Dyakov.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 9-10, December 1988.

Descriptors: *Soviet Union, *Hydroelectric power, *Electric power production, Regional development, Water resources development, Europe, Asia.

The Soviet Union has the second largest installed hydro capacity in the world, with a vast amount of potential still remaining. The aggregate capacity of Soviet hydro stations is at present 63 GW; the 1987 total national energy output was 1665 TWh, of which 217 TWh was from hydro. The target for Soviet hydro production by 1990 is an additional 245 TWh. This will be achieved by increasing the established capacities of existing hydropower stations, commissioning new plants, (9.3 GW), and refurbishment of old plants (0.3 GW). Most resources in the European part of the country already have been tapped, but many major schemes are under construction or planned on rivers in the central and east Asian parts of the U.S.S.R., for example on the Angara, Vakhsh, and Yenisey Rivers. The Soviet Union is also involved in cooperative engineering projects with countries in Asia, Africa, and Latin America. (Rochester-PTT)
W89-06209

DAM CONSTRUCTION AND HYDROPOWER DEVELOPMENT IN USSR,
Soviet Committee on Large Dams, Moscow (USSR).
For primary bibliographic entry see Field 8A.
W89-06210

SPECIALIST CONSTRUCTION PLANT DEVELOPED FOR ALZ CANAL REFURBISHMENT,
Alzwerk G.m.b.H., Burghausen (Germany, F.R.).
For primary bibliographic entry see Field 8F.
W89-06212

REJECTION BORES IN RECTANGULAR POWER CANALS,
Detroit Water and Sewerage Dept., MI.
For primary bibliographic entry see Field 8B.
W89-06213

AUTOMATION AND CONTROL: GENERAL CONCEPTS AND THEIR APPLICATION IN WATER SUPPLY AND WASTE DISPOSAL SYSTEMS,
For primary bibliographic entry see Field 5F.
W89-06235

CONTROL OF WATERWORKS: STATE OF THE ART TODAY AND FUTURE DEVELOPMENTS,
PSI, Bersaustr. 4-6, D-5620 Velbert 15 (Neviges), Federal Republic of Germany.
For primary bibliographic entry see Field 5F.
W89-06236

BRIEF INTRODUCTION TO THE REVELSTOKE PROJECT,
British Columbia Hydro and Power Authority, Vancouver.
G. M. Salmon.
Canadian Journal of Civil Engineering CJCEB8, Vol. 15, No. 5, p 784-798, October 1988. 2 tab, 8 fig, 10 ref.

Descriptors: *Powerplants, *Electrical powerplants, *Hydroelectric plants, *Electric power costs, Hydraulic models, Costs, Construction costs, Operating costs, Economic aspects, Dams, Concrete dams, Earth dams, Spillways, Reservoirs, Revelstoke Project, British Columbia.

The Revelstoke project, located in the Columbia River drainage basin in both British Columbia, Canada and the United States, includes an embankment dam, a 175 m high concrete gravity dam, a spillway, a 2700 MW powerplant, and a switchgear building. A comprehensive hydraulic model was used in refining the project layout. Constructed solely for the purpose of generating electric energy, the two billion dollar project will produce about 8 x 10 to the 9th power kWh of energy each year. It is operated as a run-of-river plant with the reservoir normally held at elevation 573 m. When the reservoir was filled to elevation 560 m, 13 m below its normal operating level, a vertical transverse crack opened in the face of the concrete dam allowing as much as 15,000 L/min of water to leak into the drainage gallery. Within 2 weeks remedial measures had closed the crack and stopped the leakage. Two months later the powerplant came into service and all other features of the project performed as expected. (White-Reimer-PTT)
W89-06242

CONSIDERATION OF BANK STORAGE WHEN DETERMINING THE POWER OUTPUT OF A HYDROELECTRIC STATION,
For primary bibliographic entry see Field 8B.
W89-06265

MULTICRITERION ANALYSIS IN TECHNICAL-ECONOMIC CALCULATIONS OF HYDROPOWER AND WATER-MANAGEMENT FACILITIES,
For primary bibliographic entry see Field 6C.
W89-06266

ANALYSIS OF THE STRESS STATE OF THE RUNNER PIT OF A HIGH-HEAD KAPLAN TURBINE,
N. I. Zubarev.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 104-108, August 1988. 2 ref. Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 29-32, February 1988.

Descriptors: *Turbines, *Hydraulic turbines, *Stress, *Stress analysis, *Concrete, Tensile stress, Runner pits, High-head Kaplan turbine, Pressure distribution.

In order to analyze the causes of destruction of the runner pit it is necessary to determine the values of the hydrodynamic loads acting on the runner pit lining from the flow and whether the calculated working conditions of the lining are sufficient for the load. The main component of the loads on the runner pit is pressure fluctuations with a blade frequency, the range of which is equal to the difference of pressures on both sides of the peripheral profile of the blade. The pit can be schematically represented as a ring in a concrete mass loaded from the inside by a time-variable pressure. Temporal variation is due to rotation of the star-shaped pressure diagram; the number of rays of the star is equal to the number of runner blades. Calculations show that the main cause of fatigue damages of the runner pit is the presence of tensile stresses in the concrete adjacent to the pit which are not taken into account. If there is no possibility of providing integrity of the concrete under the effect of these stresses or using hoop reinforcement of the concrete around the runner pit, then it seems best to calculate this pit as a ring under bending stress without support on concrete. (White-Reimer-PTT)
W89-06268

NEW TECHNOLOGICAL SOLUTIONS AND DESIGNS OF THE MECHANICAL EQUIPMENT OF STRUCTURES AT THE ROGUN HYDROELECTRIC STATION,
For primary bibliographic entry see Field 8A.
W89-06270

EXPERIENCE OF ON-SITE INVESTIGATIONS OF THE CAVITATION EROSION OF HYDRAULIC TURBINES,
G. A. Tulchinskii, and G. A. Pankratov.
Hydrotechnical Construction HYCOAR, Vol. 22, No. 2, p 120-123, August 1988. 1 tab, 1 fig, Translated from Gidrotekhnicheskoe Stroitelstvo, No. 2, p 40-42, February 1988.

Descriptors: *Hydraulic turbines, *Turbines, *Hydroelectric plants, *Cavitation, Runner blades, Three-dimensional template, Ust-Ilim hydroelectric station, USSR, Maintenance.

Correction of the runner blade profile with the use of a three-dimensional template markedly reduced the intensity of cavitation erosion. Tests established an optimal load range from 195-215 mW. Deviations from this range lead to a pronounced increase of cavitation erosion. A change in the profile of the trailing edges of the runner blades practically completely eliminated cavatational erosion on the rear surface of the blades near the trailing edges. Tests with hard-facing of the damaged blades by various electrodes showed the possibility of a substantial increase of the cavitation resistance of the hard-faced coating and accordingly an increase of the overhaul period with the use of electrodes of type TsN-22 (White-Reimer-PTT)
W89-06271

DESIGN, TECHNOLOGY OF MANUFACTURE AND INSTALLATION OF PRESTRESSED ANCHORS FOR SUPPORTING THE UNDERGROUND WORKINGS OF THE 'CHAIRA' PUMPED-STORAGE STATION.
For primary bibliographic entry see Field 8A.
W89-06273

THREE-EMBANKMENT DAMMING OF THE DIVERSION CANAL AT THE CONSTRUCTION SITE OF THE HOA BINH HYDRO DEVELOPMENT IN VIET NAM,
For primary bibliographic entry see Field 8A.
W89-06274

8D. Soil Mechanics

INFILTRATION AND HYDRAULIC CONDUCTIVITY OF A COMPACTED EARTHEN LINER,
Illinois State Geological Survey Div., Champaign.
For primary bibliographic entry see Field 5B.
W89-06199

Group 8D—Soil Mechanics

STATISTICAL ANALYSIS OF GEOTECHNICAL DATA,
Nexus Associates, Wayland, MA.
For primary bibliographic entry see Field 7C.
W89-06651

ERROR ANALYSIS FOR GEOTECHNICAL ENGINEERING,
Nexus Associates, Wayland, MA.
For primary bibliographic entry see Field 7C.
W89-06652

STATISTICAL QUALITY CONTROL OF ENGINEERED EMBANKMENTS,
Nexus Associates, Wayland, MA.
G. Baecher.
Available from the National Technical Information Service, Springfield, VA 22161, as AD-A186 796. Price codes: A06 in paper copy, A01 in microfiche. Contract Report GL-87-2, September 1987. Final Report. 167p, 43 fig, 8 tab, 10 plates, 15 ref. Department of the Army Contract DACW39-83-M-0067.

Descriptors: *Quality control, *Embankments, *Statistical analysis, *Civil engineering, Field tests, Soil engineering, Compaction, Dam construction, Planning, Inspection, Sampling.

The purpose of this report is to provide potential users of statistical quality control of engineered fills with an introduction to practical concepts, definitions, and techniques. Quality control in construction has characteristics which are both similar to and different from quality control in manufacturing. The control of quality in dam projects, especially concerning the placement and compaction of engineered embankments, is critical to the safety and performance of the entire project. Consequently, a well planned inspection program is considered essential on any moderately large project. Statistical quality control uses simple probability theory to develop inspection sampling plans. These plans make efficient use of resources, and can be related to a quantitative confidence in the quality of a finished product. Fundamentals of probability and statistics are summarized, basic concepts of statistical quality control (including sampling theory are presented, and field control of compaction operations is briefly reviewed. In addition, quality-control chart techniques are presented and the design (i.e., planning) of sampling schemes for field use is described. (Lantz-PTT)
W89-06666

8E. Rock Mechanics and Geology

ENGINEERING AND ENVIRONMENTAL GEOLOGY OF THE INDIAN WELLS VALLEY AREA, SOUTHEASTERN CALIFORNIA,
Naval Weapons Center, China Lake, CA.
For primary bibliographic entry see Field 4C.
W89-05911

GEOTECHNICAL CONSIDERATIONS FOR DESIGN OF THIN ARCH DAMS,
Army Engineer District, Jacksonville, FL. Geotechnical Branch.
For primary bibliographic entry see Field 8A.
W89-05912

CALCULATION OF THE DEPTH OF SCOUR IN ROCK DOWNSTREAM OF A SPILLWAY,
For primary bibliographic entry see Field 8B.
W89-06211

8F. Concrete

SPECIALIST CONSTRUCTION PLANT DEVELOPED FOR ALZ CANAL REFURBISHMENT,
Alzwerk G.m.b.H., Burghausen (Germany, F.R.).
H. Waechter, W. Haug, and U. Hahn.
International Water Power and Dam Construction IWPCDM, Vol. 40, No. 12, p 35-38, December 1988. 2 fig.

Descriptors: *Hydroelectric plants, *Canals, *Construction methods, *Construction management, Concrete, Liners, Rehabilitation, Sealants, West Germany.

The 50-MW powerplant near Burghausen on the Salzach River, West Germany, has a 16-km headrace (Alz Canal) constructed in 1916-22. The cast in situ concrete lining of the canal was inspected in 1981 and, as a result, a refurbishment program was carried out during powerplant shutdown periods in 1984-1987. The particular challenges associated with this rehabilitation program were: repair of very steep slopes (1:1.25); a jointless lining; minimum permissible decrease in flow cross-section due to liner thickness; minimum coefficient of roughness for the new lining; and minimum shutdown periods for the powerplant. Of the several new techniques developed for this project, four are described in detail here: (1) placing an asphaltic concrete lining over an area totalling 89,600 sq m; (2) sealing one 700-m section of the canal using concrete cast in situ on the bottom of the channel and prefabricated concrete slabs placed on the slopes; (3) placing a Wacker-m-polymer (plastic coating) on top of the concrete and asphaltic concrete over an area of 73,000 sp m; and (4) examining of the gallery to plan a future drilling and backfilling program. (Rochester-PTT)
W89-06212

ANALYSIS OF THE STRESS STATE OF THE RUNNER PIT OF A HIGH-HEAD KAPLAN TURBINE,
For primary bibliographic entry see Field 8C.
W89-06268

8G. Materials

SIMPLIFIED PROCEDURE TO EVALUATE LIQUID COLUMN SEPARATION PHENOMENA,
Universidad Nacional Autonoma de Mexico, Mexico City. Inst. de Ingenieria.
For primary bibliographic entry see Field 8B.
W89-06214

INVESTIGATION OF THE STRESS-STRAIN STATE OF LOCK GATES ON A STRAIN-GAUGE MODEL,
For primary bibliographic entry see Field 8A.
W89-06269

EFFECT OF PRESSURE FLUCTUATIONS ON PIPE FAILURE IN WATER DISTRIBUTION SYSTEMS,
Akron Univ., OH. Graduate School.
For primary bibliographic entry see Field 8B.
W89-06938

8I. Fisheries Engineering

ABNORMALITIES AND DISEASES OBSERVED IN COMMERCIAL FISH CATCHES FROM BISCAYNE BAY, FLORIDA,
For primary bibliographic entry see Field 5C.
W89-06050

DETERMINING THE RELATIONSHIP BETWEEN WATER QUALITY AND INFECTIOUS DISEASE IN FISHERY POPULATIONS,
North Carolina State Univ. at Raleigh. Coll. of Veterinary Medicine.
For primary bibliographic entry see Field 5C.
W89-06051

FISH TUMORS AND ECOLOGICAL SURVEILLANCE: A CAUTIONARY EXAMPLE FROM PORT PHILLIP BAY,
British Industrial Biological Research Association, Carshalton (England).
For primary bibliographic entry see Field 5C.
W89-06052

FISH EMBRYOS: PRACTICAL INDICATORS OF ENVIRONMENTAL QUALITY OF SIGNIFICANCE TO FISHERIES,
National Marine Fisheries Service, Milford, CT. Milford Lab.
For primary bibliographic entry see Field 5A.
W89-06055

OFF-FLAVOR IN THE CHANNEL CATFISH (ICTALURUS PUNCTATUS) DUE TO 2-METHYLISOBORNEOL AND ITS DEHYDRATION PRODUCTS,
Mississippi State Univ., Mississippi State. Coll. of Veterinary Medicine.
For primary bibliographic entry see Field 5A.
W89-06114

EFFECTS OF DEPOSITED SAND ON OVA SURVIVAL AND ALEVIN EMERGENCE IN BROWN TROUT (SALMO TRUTTA L.),
Umea Univ. (Sweden). Dept. of Animal Ecology.
For primary bibliographic entry see Field 6G.
W89-06147

REHABILITATIVE REDEVELOPMENT OF THE FISH AND FISHERIES OF THE BALTIC SEA AND THE GREAT LAKES,
Toronto Univ. (Ontario). Dept. of Zoology.
H. A. Regier, P. Tuunainen, Z. Russek, and L. E. Persson.
Ambio AMBOCX, Vol. 17, No. 2, p 121-130, 1988. 4 fig, 1 tab, 38 ref.

Descriptors: *Fish management, *Great Lakes, *Baltic Sea, *Fisheries, *Lake restoration, *Water resources development, *Resources management, Trophic level, Fish, Salmon, Lakes, Eutrophication, Future planning, Management planning.

From the perspective of the broad similarities in the geologic, physiographic, hydrologic, meteorologic and anthropologic features of the Baltic and Great Lakes Basins, there exist similarities in fish associations and fishery regimes. Similarities of recent historic processes of cultural eutrophication and oligotrophication, degradation and recovery of fish associations (assemblage of fish species) through fishery-related practices, and interactions between these two broad processes are described. The differences between these aquatic ecosystems do not outweigh the similarities. Cultural practices that have a degrading influence on the Basins are gradually being reformed and recovery processes are being fostered, especially with respect to fish associations. Several objectives are stressed for both basins: (1) increase the abundance and total allowable catches of highly preferred stocks that were once abundant; (2) conserve the valued stocks that are now abundant, including some introduced salmonines in the great Lakes, recognizing that some of the valued taxa will wane again due to natural and human causes; (3) supplement the natural productivity of the most desirable stocks (salmonines, acipenserids, large percids) by using hatcheries and nursery areas; (4) suppress undesirable species, especially certain non-native or exotic species, such as the sea lamprey that preys upon preferred species in the Great Lakes; (5) reduce the concentration of contaminants in the flesh of fish, ultimately by stopping the release of contaminants at the sources, but proximally by managing the ecosystem and its trophic network, in part through fishing, so that bioconcentration and bioaccumulation processes are contained; and (6) reduce wasteful fisheries practices, especially related to capture of undersized fish of valued taxa and capture of nontargetted species. (Geiger-PTT)
W89-06166

ENERGY ANALYSIS APPROACH TO ECOSYSTEM REDEVELOPMENT IN THE BALTIC SEA AND GREAT LAKES,
Askoe Lab., Stockholm (Sweden).
For primary bibliographic entry see Field 6A.
W89-06167

FISH PRODUCTION IN SMALL OXIDATION PONDS,
Murdoch Univ. (Western Australia). School of Environmental and Life Science.
For primary bibliographic entry see Field 5D.
W89-06224

EFFECTIVENESS OF A FISH BARRIER DAM IN LIMITING MOVEMENT OF ROUGH FISHES FROM A RESERVOIR INTO A TRIBUTARY STREAM,
Tennessee Technological Univ., Cookeville. Dept. of Biology.
F. J. Bulow, M. A. Webb, W. D. Crumby, and S. S. Quisenberry.
North American Journal of Fisheries Management NAJMDP, Vol. 8, No. 2, p 273-275, Spring 1988. 2 fig, 1 tab, 3 ref.

Descriptors: *Fish barriers, *Fish management, *Reservoirs, *Environmental effects, Tributaries, Rockfill dams, Gabions, Fish migration, Tennessee.

A fish barrier that was constructed on the Roaring River, tributary to Cordell Hull Reservoir, Cumberland River, Tennessee, was evaluated. The barrier was a steel-framed, stone-filled structure covered with concrete-capped gabions, and it spanned the width of the stream. One thousand fifty-six specimens of seven rough fish species were tagged over three occasions downstream from the barrier, but no tagged fish were ever recovered upstream from it. The barrier seems to be effective in limiting upstream migration of rough fishes. (Author's abstract)
W89-06289

ESTIMATION OF PRODUCTION FORGONE,
Michigan Univ., Ann Arbor. School of Natural Resources.
For primary bibliographic entry see Field 6G.
W89-06290

DISTRIBUTION OF UPPER AND MIDDLE OHIO RIVER FISHES, 1973-1985: I. ASSOCIATIONS WITH WATER QUALITY AND ECOLOGICAL VARIABLES,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
J. H. Van Hassel, R. J. Reash, H. W. Brown, J. L. Thomas, and R. C. Mathews.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 441-458, December 1988. 4 fig, 2 tab, 35 ref.

Descriptors: *Fish populations, *Fish, *Ohio River, *Ecological distribution, *Species composition, *Water quality, Species diversity, Rivers, Aquatic environment, Powerplants, Data collections.

More than 200,000 adult and juvenile fishes of 100 species were collected near five electric generating plants located in the upper and middle Ohio River during 1973 through 1985. Catches were dominated by Notropis atherinoides, Dorosoma cepedianum, Pimephales notatus, Ictalurus punctatus, Cyprinus carpio, Lepisosteus osseus, Lepomis macrochirus, Pomoxis annularis, Notropis blennius, and Aplodinotus grunniens. Twenty-nine species occurred with greater frequency in the upper Ohio River, whereas 17 species were found predominately in the middle Ohio River sampling areas. Classification of these species based upon mode of reproduction, habitat preference, and mode of feeding indicated a distinct prevalence of species typically associated with smaller, free-flowing streams at upper Ohio River sampling sites. Species typically found in large, slow-moving water bodies dominated at middle Ohio River sites. These fish distributional trends may be partially related to significant upper-middle Ohio river differences in water quality. Twenty-two species significantly increased in abundance from 1973 to 1985, but catches of seven species declined. Many species with increased catch rates were forage and sport fishes most likely responding to water quality improvements. Many species decreasing in catch rates were pollution-tolerant. These findings are strong evidence of positive changes in the Ohio River fishery in recent years. (See also W89-06319) (Author's abstract)
W89-06318

DISTRIBUTION OF UPPER AND MIDDLE OHIO RIVER FISHES, 1973-1985: II. INFLUENCE OF ZOOGEOGRAPHIC AND PHYSIOCHEMICAL TOLERANCE FACTORS,
American Electric Power Service Corp., Columbus, OH. Environmental Engineering Div.
R. J. Reash, and J. H. Van Hassel.
Journal of Freshwater Ecology JFREDW, Vol. 4, No. 4, p 459-476, December 1988. 3 tab, 32 ref, append.

Descriptors: *Fish populations, *Fish, *Ohio River, *Ecological distribution, *Species composition, Water quality, Rivers, Powerplants, Water pollution effects, Temperature effects, Data collections, Aquatic habitats, Species diversity, Population dynamics, Statistical analysis.

Catch data for 58 Ohio River species collected near five power plant sites during 1973-1985 were used to test the hypothesis that the distributional tendency and site-specific community structure of Ohio River fishes were associated with certain zoogeographic and physiochemical tolerance factors. Spearman rank correlations were tolerance factors and distributional tendencies of each species, as well as for score values and average catch per unit effort rank values of species at each plant site. Tributary abundance, habitat preference, range proximity, and pollution tolerance of species were significantly associated with the distributional tendency of Ohio River fishes. At site-specific locations, the most important factor associated with the composition and abundance of fishes near upper and middle Ohio River power plants were (in decreasing order of importance); tributary abundance, habitat preference, pollution tolerance and range proximity, and optimal temperature. There was a general trend of both increasing numbers of significant factors and increasing r values from upstream to downstream. For all factors except pollution tolerance, the strongest associations occurred at the furthest downstream plant site. (See also W89-06318) (Author's abstract)
W89-06319

EFFECTS OF HYDROLOGICAL CHANGE AND THE CESSATION OF STOCKING ON A STREAM POPULATION OF SALMO TRUTTA L.,
Tasmanian Inland Fisheries Commission, Hobart (Australia).
For primary bibliographic entry see Field 6G.
W89-06329

CHANGES IN THE GEORGIAN BAY FISH COMMUNITY, WITH SPECIAL REFERENCE TO LAKE TROUT (SALVELINUS NAMAYCUSH) REHABILITATION,
Ontario Ministry of Natural Resources, Toronto. Lake Huron Fisheries Research Unit.
For primary bibliographic entry see Field 2H.
W89-06347

CHANGES IN THE NORTH CHANNEL FISH COMMUNITY WITH EMPHASIS ON PINK SALMON (ONCORHYNCHUS GORBUSCHA WALBAUM),
Ontario Ministry of Natural Resources, Toronto. Lake Huron Fisheries Research Unit.
J. J. Collins.
Hydrobiologia HYDRB8, Vol. 163, p 195-213, June 20, 1988. 11 fig, 2 tab, 87 ref.

Descriptors: *Species composition, *Succession, *Salmon, *Fish establishment, *Lakes, *Fisheries, *Lake Huron, Great Lakes, Fish populations, Pink salmon, Sturgeon, Smelt, Lamprey, Lake trout, Trout, Burbot, Whitefish, Cisco, Alewife, Walleye, Commerical fishing, Fish harvest, Predation, Food chains, Acid rain, Metals.

Historical trends in commercial fishery yields were examined for evidence of structural changes in the North Channel fish community. Significant declines in the abundance of indigenous species occurred primarily as a result of man's activities. Lake sturgeon (Acipenser fulvescens) were harvested down to low levels by 1900. Introductions of exotics to the fish community were associated with major changes. Rainbow smelt (Osmerus mordax) and sea lamprey (Petromyzon marinus) colonized the channel in the late 1930s. Concurrently, lake trout (Salvelinus namaycush) and burbot (Lota lota), the top deepwater predators, declined to near extinction. Lake whitefish (Coregonus clupeaformis) and shallow-water cisco (Coregonus artedii) also declined. Without predation pressure, smelt abundance increased to high levels in the 1950s and alewife (Alosa pseudoharengus), another exotic, peaked during the 1960s. Both species equilibrated at lower levels in the 1970s, perhaps favoring colonization by pink salmon (Oncorhynchus gorbuscha). Pink salmon which are larger and more fecund in Lake Huron than in Lake Superior, have increased rapidly in numbers and have expanded their range in the channel. Certain whitefish stocks have increased sufficiently to support fishery yields greater than those of the 1930s, despite considerable exploitation pressure. This success is partially in reponse to the control of sea lamprey since 1961. However, both lake whitefish and walleye (Stizostedion vitreum) are now rare in the east end of the channel, possibly due to environmental factors such as acid precipitation and metal contaminants. (Author's abstract)
W89-06348

AERATION OF LAKE MUTEK AS A METHOD OF RECULTIVATION: RANGE OF STUDIES AND LAKE MORPHOLOGY (NAPOWIETRZANIE JEZIORA MUTEK JAKO METODA REKULTYWACJI ZAKRES BADAN I MORFOLOGIA ZBIORNIKA),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
For primary bibliographic entry see Field 5G.
W89-06356

PHYTOPLANKTON OF AN ARTIFICIALLY AERATED LAKE MUTEK (PLANKTON ROSLINNY JEZIORA MUTEK PODDANEGO SZTUCZNEMU NAPOWIETRZANIU HYPOLIMNIONU),
Instytut Rybactwa Srodladowego, Piaseczno (Poland). Zaklad Rybactwa Stawowego.
For primary bibliographic entry see Field 5G.
W89-06360

ZOOPLANKTON IN ARTIFICIALLY AERATED LAKE MUTEK IN THE PERIOD 1977-1980 (ZOOPLANKTON SZTUCZNIE NAPOWIETRZANEGO JEZIORA MUTEK W LATACH 1977-1980),
Akademia Rolniczo-Techniczna, Olsztyn-Kortow (Poland). Inst. of Hydrobiolgy and Water Conservation.
For primary bibliographic entry see Field 5G.
W89-06364

CHANGES IN FISHERY PRODUCTION OF LAKE MUTEK (ZMIANY PRODUKCJI RYBACKEIJ JEZIORA MUTEK),
Instytut Rybactwa Srodladowego, Olsztyn-Kortowo (Poland).
For primary bibliographic entry see Field 5G.
W89-06365

OCCURRENCE AND DIET OF FISHES IN A TIDAL INLET TO A SALTMARSH IN SOUTHERN MORETON BAY, QUEENSLAND,
Queensland Dept. of Primary Industries, Brisbane (Australia). Fisheries Management Branch.
For primary bibliographic entry see Field 2L.
W89-06372

PHYSIOLOGICAL EFFECTS OF COLLECTING AND TRANSPORTING EMIGRATING JUVENILE CHINOOK SALMON PAST DAMS ON THE COLUMBIA RIVER,
Oregon Cooperative Fishery Research Unit, Cor-

vallis.
A. G. Maule, C. B. Schreck, C. S. Bradford, and B. A. Barton.
Transactions of the American Fisheries Society TAFSAI, Vol. 117, No. 3, p 245-261, May 1988. 14 fig, 39 ref. Bonneville Power Administration Contract DE-A179-82BP3479; Army Corps of Engineers Contract DACW68-84-C-0063.

Descriptors: *Salmon, *Fish migration, *Fish physiology, *Fish management, *Dam effects, *Columbia River, Migration, Physiological ecology, Juvenile growth stage, Mortality, Dams, Stress, Flow, Blood, Rivers, Fish.

Emigrating juvenile salmonids are collected at McNary Dam on the Columbia River and transported past the three downstream dams to avoid mortalities caused by passage through power-generating turbines. During the 1982-1984 seaward migrations of juvenile fall and spring chinook salmon Oncorhynchus tshawytscha, an array of physiological measurements (plasma cortisol and glucose, white blood cell counts) and challenge tests (saltwater challenge, secondary stress, and swimming endurance) were used to identify the stressful elements in these activities. Sequential increases in plasma cortisol titers of fish sampled at the physically separable points in the collection led to the conclusion that the elements of the system stressed fish cumulatively. Furthermore, there were decreases in numbers of white blood cells, in osmoregulatory ability, and in swimming endurance during the first 24 h after fish were collected. Increasing the water flow rate in the system after the 1982 season seemed to reduce total stress. The most stressful event in transportation appeared to be the loading of fish into a tank or truck barge. Fish recovered from the stress of loading while en route, and thus recovered more fully during the 16-h trip by barge than during the 3-h trip by truck. Physiological responses did not differ in fish transported in trucks at densities of 0.02-0.36 kg/L. Although there were no significant differences between the responses of fish collected at various times during the migrations, apparent differences between the responses of fall and spring chinook salmon suggested that the latter were more sensitive to the stresses of collection. (Author's abstract)
W89-06506

RELATION OF STREAMFLOW TO HABITAT FOR ANADROMOUS FISH IN THE STILLAGUAMISH RIVER BASIN, WASHINGTON,
Geological Survey, Tacoma, WA. Water Resources Div.
For primary bibliographic entry see Field 2E.
W89-06832

9. MANPOWER, GRANTS AND FACILITIES

9A. Education (Extramural)

BYELORUSSIAN SCHOOL OF HYDROBIOLOGISTS AND ITS ACHIEVEMENTS (BELORUSSKAYA SHKOLA GIDROBIOLOGOV I EE DOSTIZHENIYA),
Akademiya Navuk BSSR, Minsk.
N. M. Kryuchkova.
Gidrobiologicheski Zhurnal GBZUAM, Vol. 24, No. 3, p 84-95, 1988. 47 ref. English summary.

Descriptors: *Hydrobiology, *Byelorussia, *Education, *Research, Reviews, Fisheries.

The basic results of research studies conducted by the Byelorussian school of hydrobiologists created and headed by G. G. Winberg for 20 yr are reviewed. The most important achievements in sanitary hydrobiology, hydrobiological fundamentals of fisheries, and general hydrobiology are considered. (Author's abstract)
W89-06573

9D. Grants, Contracts, and Research Act Allotments

NEVADA FISCAL YEAR 1987 PROGRAM REPORT (NEVADA WATER RESOURCES RESEARCH INSTITUTE).
Nevada Univ. System, Reno. Water Resources Center.
Available from National Technical Information Service, Springfield, VA 22161 as PB89 100572/AS, Price codes: A03 in paper copy, A01 in microfiche. Desert Research Institute, Water Resources Center, Program Report G1435-01, July 1988. 24p. USGS contract 14-08-0001-G1435. USGS project USGS G1435-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Nevada, Education, Projects.

Nevada's arid climate limits the available water supply, yet attracts increasing numbers of people. Nevada is experiencing marked pressures in its water resources as a result of this burgeoning population. As the population increases, traditional uses of water are changing as well, generally from rural to urban. One of the 1987 research projects investigated optimal water management and investment strategies for rural communities faced with risks in forecasting future municipal water demands. As reliance on private wells and individual septic systems continues to increase in suburban areas of Nevada, groundwater quality is a concern. The objective of one research project was to delineate source areas for nitrate and ammonia using a technique known as nitrogen isotope ratios. A third project is investigating an economical means of upgrading wastewater effluents for water reuse. Because agriculture is being forced to consider the possibilities of utilizing poorer quality water, knowledge of salt effects on crop plant water use and productivity is essential. One research project was developed to study the influence of varying leaching fractions, water quality and soil type on root distribution and fractional water uptake. A total of three undergraduate and four graduate level students participated in the 1987 program. (Cosens-NV. U.)
W89-06878

FISCAL YEAR 1986 PROGRAM REPORT (GUAM WATER AND ENERGY RESEARCH INSTITUTE).
Guam Univ., Agana. Water Resources Research Center.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 210695/AS, price codes: A03 in paper copy; A01 in microfiche. Program Report G-1220-1, July 1987. 21p. USGS contract 14-08-0001-G1220. USGS project G1220-01.

Descriptors: *Water Research Institute, *Education, *Research, *Information transfer, *Guam, Training.

An overview of the Fiscal Year 1986 research and information transfer activities accomplished by the University of Guam Water and Energy Research Institute is given. These activities were sponsored by the Water Research Institute Program Grant of the U.S. Geological Survey and included the following completed projects: (1) Improving the water distribution systems at Kolonia, Pohnpei state, through use of a digital water distribution model; (2) Documentation of ancient water conveyance systems in the Federated States of Micronesia, States of Truk, Pohnpei, and Kosrae, and in the Territory of Guam; (3) An analysis of water rights issues in Saipan, the Territory of Guam, and the Republic of Belau; (4) Atoll groundwater development modelling, Laura Island. (USGS)
W89-06897

FISCAL YEAR 1987 PROGRAM REPORT (VERMONT WATER RESOURCES RESEARCH CENTER),
Vermont Water Resources Research Center, Burlington.
A. W. McIntosh.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 244769/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1453-01, July 1988. 22p. USGS contract 14-08-0001-G-1453. USGS project G1453-01.

Descriptors: *Water Research Institute. *Vermont, *Research, *Information transfer, *Training, Education.

Both surface and groundwater issues were addressed in the FY87 Vermont Water Resources Research Center program. Two projects focused on groundwater, with one assessing techniques for reducing nitrate contamination in agricultural areas and a second comparing techniques for monitoring microbial contamination. A third project considered the role of acid deposition in the fate of aluminum in soils and water, while the final effort focused on the relationship between phosphorus and stream algal communities. Information transfer activities included a workshop on toxic substances in Lake Champlain, an annual spring meeting and the production of two newsletters in cooperation with the Vermont Extension Service. (McIntosh-U. VT, WRRC)
W89-06898

FISCAL YEAR 1987 PROGRAM REPORT (RHODE ISLAND WATER RESOURCES CENTER),
Rhode Island Univ., Kingston. Water Resources Center.
C. P. C. Poon.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 244751/AS, price codes: A04 in paper copy; A01 in microfiche. Program Report G1447-01, July 1988. 45p. USGS contract 14-08-0001-G1447. USGS project G1447-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Rhode Island.

The 1987 program objective was to conduct studies and research of value to the New England region as well as to assist in the solution of problems in the State of Rhode Island. Current and anticipated state regional water problems are contamination of surface and groundwater by natural radioactivity such as radon, by chemicals from industrial and agricultural activities, septic tank and leach field, improperly managed landfills and the lack of public awareness and public participation in water quality protection and management. It was found in the 1987 program that an epithermal neutron activation analysis was most suitable for measuring uranium and thorium of which radon is the decayed product. Lower U and Th were found in calc-alkalic and mafic volcanic rocks while higher concentrations were found in the alkalic and peraluminous rocks. A computer model using finite element method to simulate fluid flows through fractured porous media was developed for predicting the extent of groundwater contamination in the State. Techniques were developed to use metal resistant bacteria Arthrobacter HC823 for metal removal from plating wastes. Nitrogen and phosphorus contaminants were found short distances from the drainage field of septic tank systems. Educational programs in water resources issues included conference, fact sheet publication, and citizen watershed watch. Handbook and short courses were either conducted or being initiated. Mixed ash from a mass-burn incinerator contained sufficient cadmium to be classified as toxic substance using TCLP procedure but sufficient lead to be classified as toxic using either EPTC or TCLP procedure. This Center works closely with the R. I. Dept. of Environmental Management; USGS subdistrict office, R. I. Solid Waste Management Corp., and other New England Water Resources Centers for program planning and research coordination. (USGS)
W89-06900

FISCAL YEAR 1987 REPORT (MISSISSIPPI WATER RESOURCES RESEARCH INSTITUTE),
Mississippi State Univ., Mississippi State. Water Resources Research Inst.
M. T. Bond.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 246616/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1431-01, July 1988. 24p. USGS contract 14-08-0001-G1431. USGS project G1431-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Mississippi, Education, Project.

During the 1987 program year, the Mississippi Institute was involved with statewide planning and research, including the following projects: Project G1431-02 (year 1 of 2) is developing a physically based methodology which will determine the fate of pollutants in rural drainage systems. Project G1431-03, an attempt to determine if analysis of plasmid size profile of bacteria in freshwater could determine the source of bacteria, provided one of the few baseline studies of plasmid size profiles in natural waters. Project G1431-04 investigated environment water quality to grow freshwater shrimp. Project G1431-05 explored the use of clinoptilolite to remove toxic ammonia from catfish pond waters. Project G1431-06 developed a sediment transport model for field applications. Project G1431-07 is in the process of identifying social and economic barriers to farmers' adoption of conservation technologies. Project G1431-08 (year 1 of 2) is developing a drought/emergency plan for short-term emergency situations. Project G1431-02 supported the Institute program though information dissemination and water resources conference. (Hawkins-MS U., WRRI)
W89-06901

FISCAL YEAR 1987 PROGRAM REPORT (INDIANA WATER RESOURCES RESEARCH CENTER),
Purdue Univ., Lafayette, IN. Water Resources Research Center.
J. H. Cushman.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 246855/AS, price codes: A03 in paper copy, A01 in microfiche. 23rd Annual Report G1421-01, August 1988. 42p, 1 tab. USGS contract 14-08-0001-G1421. USGS project G1421-01.

Descriptors: *Water Research Institute, *Indiana, *Research, *Information transfer, *Training, Education, Projects.

The 1987 program of the Indiana Water Resources Research Center has revolved around five research projects and a technology transfer program. In addition to these activities, the Center was heavily involved in a proposal to develop an Egyptian Water Resources Research Center through U.S. AID. One research project, directed by V.J. Bierman of the University of Notre Dame, focused on studying the impacts of toxic chemicals on water bodies within a quantitative framework in order to provide a basis for regulation in the form of waste load allocations. S. E. Silliman, also with the University of Notre Dame, conducted a study based on delineating the structure present within random conductivity distributions which will directly influence subsurface transport. A third project, led by D. D. Ross of Indiana University - Purdue University at Fort Wayne, focused on measuring the dose-response relationship between heavy metal concentration and biomass, and activity and functional diversity of the epilithic bacterial community. R. F. Turco and A. E. Konopka, of Purdue University, conducted a study which was concerned with agricultural impacts on groundwater quality. They sought to establish the levels of selected agricultural chemicals and nitrates in well water. N. C. Krothe, of Indiana University, directed the last project which was aimed at analyzing nitrate in groundwater in an area of suspected macropore flow through a thick unconsolidated mantle to a karst bedrock aquifer. The technology transfer program involved meetings with various national, state, and private entities, invited presentations to several groups, and Center newsletter. (Cushman-Purdue U., WRRC)
W89-06902

FISCAL YEAR 1987 PROGRAM REPORT (VIRGINIA WATER RESOURCES RESEARCH CENTER),
Virginia Polytechnic Inst. and State Univ., Blacksburg. Water Resources Research Center.
W. R. Walker.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 246848/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G 1454-01, July 1988. 22p, 1 tab, 3 append. USGS contract 14-08-0001-G1454. USGS project G1454-01.

Descriptors: *Water Research Institute, *Virginia, *Research, *Information transfer, *Training, *Education, Projects.

The Virginia Water Resources Research Center's 1987 - 1992 Five-Year Plan has focused on four major water resource issues confronting Virginia: (1) water resources planning; (2) land use effects on water resources; (3) land application of sewage sludge; and (4) water related health concerns. During the 1987 federal fiscal year, the Center sponsored six research projects and 12 students (9 graduate and 3 undergraduate). The research projects emphasized the effects of land use practices on water resources and concerned: the effects of agricultural best management practices, tillage, and land applied sewage sludge on surface water, groundwater, and nitrate leaching; targeting critical nonpoint pollution source areas in watersheds; stormwater management and urban best management practices; and the potential of natural soil micro-organisms to degrade pollutants. During the past year, the Center published six research bulletins; created a new series 'Recent and Relevant;' sponsored a research forum in concert with the North American Lake Management Society that 375 people attended; and taught a graduate-level, 10-day course in water resources education. In addition to the bulletins, noteworthy publications included the Center's monthly newsletter that won the state and national Merit Award of the Soil and Water Conservation Society for outstanding service in advancing the science and art of good land and water use. (Weigmann-VA Tech)
W89-06903

FISCAL YEAR 1987 PROGRAM REPORT (SOUTH CAROLINA WATER RESOURCES RESEARCH INSTITUTE).
Clemson Univ., SC. Water Resources Research Inst.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 246608/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1448-01, June 1988, 36p. USGS contract 14-08-0001-G1448. USGS project G1448-01.

Descriptors: *Water Research Institute, *South Carolina, *Research, *Information transfer, *Training.

Included in the report are sections on the water problems and issues of the State, the goals and priorities of the total program, the synopses of the program projects and information concerning the information dissemination program. The synopses contain information regarding research projects funded by the Water Resources Institute including (1) Richard K. White performed a groundwater resources assessment on the availability of groundwater, groundwater data and its availability to meet the state needs. (2) The effects of herbicide residues on microbial processes in aquaculture ponds and sediments were studied by Steven Hayasaka. (3) A study was conducted on the extent of the PCB contamination in the Twelve Mile River and the upper section of Lake Hartwell, S.C., by Alan W. Elzerman of the Environmental Systems Engineering Department of Clemson University. (4) The S.C. Drought Management Act uses the Palmer Index to determine the drought state relative to crop growing. The study by Dale Linvill and James Ligon determined the applicability of previously determined drought algorithms from other areas of the country to the S. C. situation. (5) Earl Hayter of Clemson University developed two contaminant transport models. One is a two-dimensional model and the other is a three-dimensional model. Both are finite element models, and have been tested. (6) There is brief discussion of the Information Transfer Program currently in effect. (Zielinski-Clemson Univ., WRRI)
W89-06904

FISCAL YEAR 1987 PROGRAM REPORT (MICHIGAN INSTITUTE OF WATER RESEARCH).
Michigan State Univ., East Lansing. Inst. of Water Research.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 239181/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1429-01, March 1988. 31p. USGS contract 14-08-0001-G1429. USGS project G1429-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Michigan, Information dissemination, Technology transfer.

The major thrust of the Michigan Institute of Water Research during the 1987 program year involved activities related to its research program, statewide water resources planning activities, use of geographic information systems and the technology transfer program. Water management planning along with surface and groundwater contamination problems are the top priorities issues in the state at the present time. Research projects funded by the Institute of Water Research to address these problems and issues included: the assessment of rural groundwater contamination by agricultural chemicals in sensitive areas of Michigan (03); the impacts of irrigation on instream flow quantity (05); an interdisciplinary approach to valuation of Michigan's coastal wetlands (02); operation, spatial and environmental water planning and analysis - phase II (04); and the development and implementation of the Institute of Water Research technology transfer program through publication and dissemination of research results, distribution of a water related newsletter and information materials, responses to requests for information, coordination of conferences and publication of conference proceedings, and the development of educational audio-visual programs (22). (USGS)
W89-06906

FISCAL YEAR 1987 PROGRAM REPORT (MISSOURI WATER RESOURCES RESEARCH CENTER).
Missouri Water Resources Research Center, Columbia.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 239199/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1432-01, June 1988. 19p. USGS contract 14-08-0001-G1432. USGS project G1432-01.

Descriptors: *Water Research Institute, *Research, *Missouri, *Training, *Information transfer.

Missouri Water Resources Research Center's goals are (1) to develop research programs in understanding and solving Missouri's water problems, (2) to provide educational opportunities in research for students with an interest in water resources and related fields, and (3) to be actively involved in dissemination of information through all aspects of the media in reaching the researchers, users and citizens of Missouri with informative water related news and research ideas on the future of Missouri's water. Areas of research covered under this grant include (a) fate and transport of particle-bound chlordane that may be major factors in chlorinated hydrocarbon contamination in fish from the many lakes and rivers in Missouri, (b) effects of macropores on the movement of agricultural chemicals through the soil profile, (c) determination of possible mechanisms for chlordane movement initiated by rainfall events, and (d) derivation of an empiri-

cal model relating suspended algal biomass in Missouri streams to prevailing physical conditions and ambient nutrient concentrations. A total of 13 students, 9 graduate students and 4 undergraduate students, were involved in this year's research programs. (Clevenger-MO U.)
W89-06907

FISCAL YEAR 1987 PROGRAM REPORT (DELAWARE WATER RESOURCES CENTER),
Delaware Univ., Newark. Water Resources Center.
R. D. Varrin.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 239389/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1413-01, July 1988. 30p. USGS contract 14-08-0001-G1413. USGS project G1413-01.

Descriptors: *Water Research Institute, *Delaware, *Research, *Information transfer, *Training.

The Fiscal Year 1987 Delaware Water Research Institute Program focused on three critical water problems of the state and region: contamination of groundwater, maintenance of a safe and adequate water supply, and sedimentation. Five projects developed information needed by water planners, managers, and users for the protection and maintenance of Delaware's groundwater supply. Included are methods for cleanup of toxic organic compounds and petroleum products, a system for identifying water-table regimes by soil characteristics, an analysis of soil types and herbicides that quantifies potential movement of toxins into certain aquifers, and a study of watershed land use and the related impact on water quality. A sixth project explored an alternative to chlorination as a water treatment method. The final project identified causes of riverbank erosion and a natural deterrent to such erosion. (USGS)
W89-06908

FISCAL YEAR 1987 PROGRAM REPORT (MARYLAND WATER RESOURCES RESEARCH CENTER),
Maryland Univ., College Park. Water Resources Research Center.
R. E. Menzer.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 239397/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1427-01, July 1988. 30p, 2 fig. USGS project G1427-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Maryland.

In response to the goals and priorities for 1987 of the Maryland Water Resources Research Center, four projects were supported; they dealt with the question of whether nitrogen or phosphorus is the more important contributor to decline of submerged aquatic vegetation in the Chesapeake Bay, the dynamics of inorganic nitrogen in the Choptank River, the use of beryllium-10 as a sediment tracing mechanism in the Chesapeake Bay, and the long term effects of the insecticide diflubenzuron on stream metabolism. Eutrophication has had significant impact on the decline of submerged vegetation in the Chesapeake Bay. Optimum N:P ratios differed for different organisms, between vascular plants and epiphytic phytoplankton. The composition of the epiphytic community was dramatically affected both by total nutrient loading and by the N:P ratio. Although it is known that nitrogen cycling leads to the production of NH4+ from NO3- within the Bay, specific conditions which control these processes are not understood. Trends in nitrogen availability at all sampling sites with season were the same: highest concentrations of NO3- during December through May, with a rapid decline to near zero between May and June. In the summer a secondary peak in the availability of NH4+ was noted. In sedimentation studies it has been found that beryllium-10 concentrations of river-borne particles correlate roughly with the average erosion flux in a parent river basin. However, the 10Be/Fe ratio is more practical for studying the origin of sediments. Diflubenzuron is extensively used in controlling the gypsy moth. It has been shown that the compound interferes with leaf-litter processing in streams draining forested watersheds, probably through mortality of the litter-feeding biota. (Menzer-MD U., WRRC)
W89-06909

FISCAL YEAR 1986 PROGRAM REPORT (KANSAS WATER RESOURCES RESEARCH INSTITUTE),
Kansas Water Resources Research Inst., Manhattan.
H. S. Jacobs.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 188040/AS, price codes: A03 in paper copy, A01 in microfiche. Program Report G1226-01, July 1987. 27p. (Revised). USGS contract 14-08-0001-G1226. USGS project G1226-01.

Descriptors: *Water Research Institute, *Research, *Information transfer, *Training, *Kansas, Universities, Research projects, Research summaries, Research priorities.

Five research projects addressed the need to preserve the quality of Kansas water supplies: The first considered chemical contamination from minerals, pesticides and volatile organic chemicals in farmstead wells. A second project studied factors affecting the fate and transport of chlorinated hydrocarbons in soil. The third study undertook development of an improved model simulating movement of agricultural non-point pollutants during runoff events. Trihalomethanes are thought to be carcinogens and drinking water standards limit their concentrations in public water supplies. A fourth project was directed at determining the sources and possible control of trihalomethane precursors in Kansas lakes. A fifth project delineated the geochemical factors influencing water quality in northeastern Kansas where glacial, buried-valley aquifers serve as the primary source of groundwater. Withdrawal greatly exceeds recharge in the Ogallala aquifer in northwest Kansas. Research was initiated to provide a cost effective means of monitoring irrigation demand in the area. A literature review to assist in the water research priority setting process was also initiated. In addition, the water right implications of stream-aquifer interactions were reviewed in Kansas water law and the statutes of 12 western states. A total of 7 undergraduates, 11 Masters, 1 Ph.D. and 1 J.D. degree students participated in the 1986 program. (Jacobs-KS U., WRRI)
W89-06912

10. SCIENTIFIC AND TECHNICAL INFORMATION

10C. Secondary Publication And Distribution

ANNOTATED BIBLIOGRAPHY ON WELLHEAD PROTECTION PROGRAMS.
Environmental Protection Agency, Washington, DC. Office of Ground-Water Protection.
Available from the National Technical Information Service, Springfield, VA 22161, as PB88-148754. Price codes: A04 in paper copy, A01 in microfiche. August 1987. 75p.

Descriptors: *Water pollution prevention, *Bibliographies, *Wells, *Groundwater protection, Environmental protection, Water supply, Groundwater budget.

This is a bibliography referencing 142 documents that contain information on one or more of the six required program elements in the Wellhead Protection program (WHP). The purpose of this document is to provide a mechanism by which state and local officials can use the experience of others to aide in the development of their WHP programs. These references examine the following elements: duties of state and local agencies in wellhead protection programs; determination of WHP areas around supply wells; identification of contaminants in the WHP areas; describe programs of WHP; contingency plans if contamination occurs; and protection of new wells. (Author's abstract)
W89-06640

PROCEEDINGS: THIRD ANNUAL ACID RAIN CONFERENCE FOR THE SOUTHERN APPALACHIANS.
For primary bibliographic entry see Field 5B.
W89-06643

PROCEEDINGS, EIGHTEENTH MISSISSIPPI WATER RESOURCES CONFERENCE, 1988.
Mississippi State Univ., Mississippi State. Water Resources Research Inst.
For primary bibliographic entry see Field 6B.
W89-06899

10D. Specialized Information Center Services

WATER RESOURCES PROFESSIONALS IN INDIANA: A DIRECTORY,
Purdue Univ., Lafayette, IN. Water Resources Research Center.
J. H. Cushman.
Available from National Technical Information Service, Springfield, VA 22161 as PB88 195888/AS, price codes: A05 in paper copy, A01 in microfiche. 1988 Edition, February 1988, 67p. USGS contract 14-08-0001-G1421. USGS project G1421-22.

Descriptors: *Directories, *Indiana, *Information transfer, *Research personnel, State agencies, Federal agencies, Professional organizations.

The Indiana Water Resources Research Center has published the directory to identify and encourage communication among these researchers and organizations involved with preserving, protecting, and improving Indiana's water resources. The directory will be of use to members of the water research community as well as to members of public agencies and private organizations in the water resources area. The use of the directory is to be encouraged as a means of direct contact with researchers. (Cushman-Purdue Univ., WRRC)
W89-06910

GROUNDWATER MAPPING: THE INFORMATION EXCHANGE BETWEEN MAP USERS AND MAP MAKERS,
Clark Univ., Worcester, MA. Dept. of Geography.
For primary bibliographic entry see Field 7C.
W89-06961

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National Surface Water Survey. National Stream Survey Phase I. Pilot Survey--Summary of Quality Assurance Data Results,
W89-06646 7B

Annual Report, 1985: National Acid Precipitation Assessment Program.
W89-06650 5B

Summary Report for the National Atmospheric Deposition Program/National Trends Network (NADP/NTN) Site Visitation Program: for the Period December, 1984 through September, 1986,
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Subject Fields

1 **NATURE OF WATER**

2 **WATER CYCLE**

3 **WATER SUPPLY AUGMENTATION AND CONSERVATION**

4 **WATER QUANTITY MANAGEMENT AND CONTROL**

5 **WATER QUALITY MANAGEMENT AND PROTECTION**

6 **WATER RESOURCES PLANNING**

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1989 Price Schedules for the United States, Canada, and Mexico

These prices are for customers in the United States, Canada, and Mexico; other customers, write for price list PR-360-4.

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Standard Prices		*Exception Prices*	
A01	$6.95	E01	$9.00
A02	10.95	E02	11.50
A03	13.95	E03	13.00
A04-A05	15.95	E04	15.50
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A10-A13	28.95	E06	20.50
A14-A17	36.95	E07	23.00
A18-A21	42.95	E08	25.50
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Published Searches & Special Directories		E15	46.00
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		E17	54.50
		E18	59.00
		E19	65.50
N01	$55.00	E20	76.00
N02	55.00	E99	*

Computer Products

Diskettes		*Magnetic Tapes*	
D01	$50	T01	$150
D02	75	T02	210
D03	125	T03	325
D04	175	T04	425
D05	225	T05	525
D06	275	T06	625
D07	325	T07	725
D08	375	T08	825
D09	425	T09	925
D10	475	T10	1,025
D11	525	T11	1,125
D12	575	T12	1,225
D13	625	T13	1,325
D14	675	T14	1,425
D15	725	T15	1,525
D16	775	T16	1,625
D17	825	T17	1,725
D18	875	T18	1,825
D19	925	T19	1,925
D99	*	T99	*

* Contact NTIS for price

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